CPU®
COMPUTER POWER USER

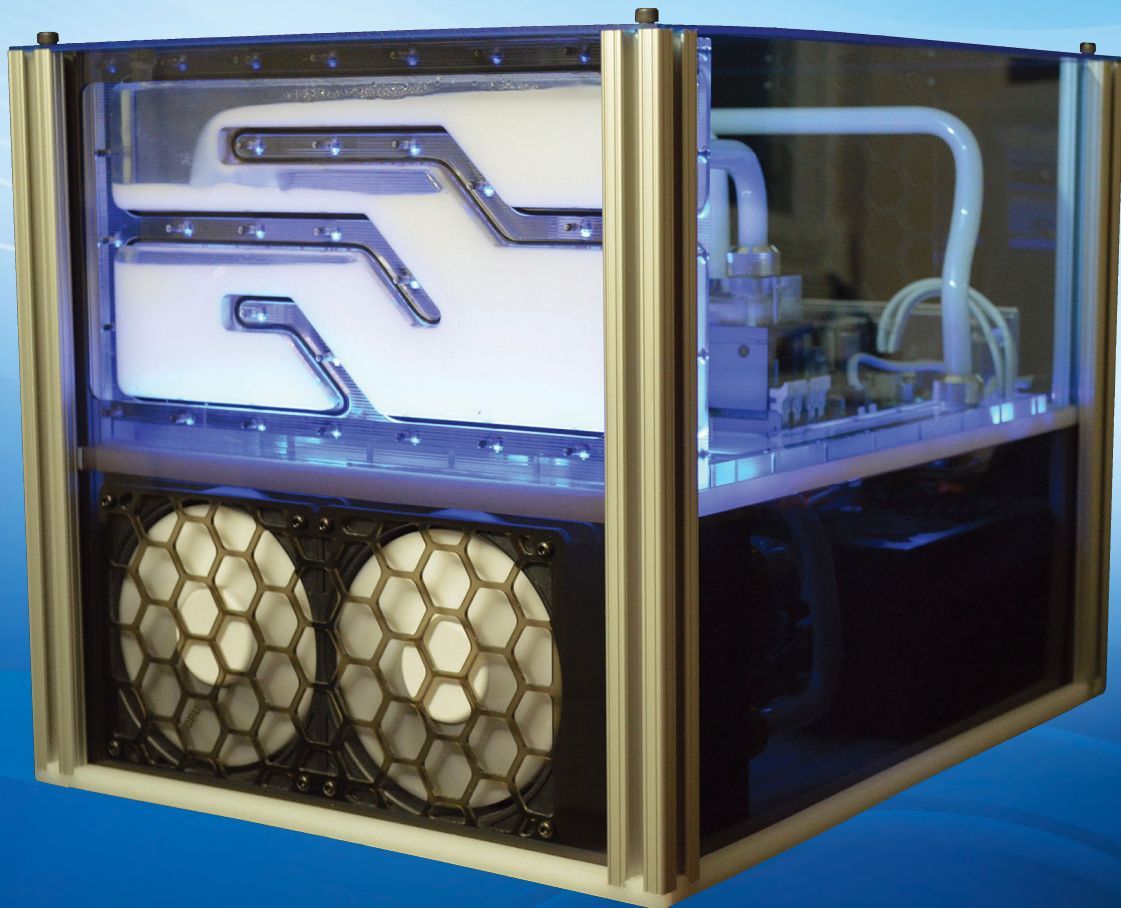**MODDER Q&A**
DAVID "INSOLENTGNOME" CATHEY

MRM™
MAD READER MOD

PHANTASM

A CUSTOM MASTERPIECE BY MARIO "RADIKULT" RODRIGUEZ

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Monitor Buyer's Guide

DID YOU FIND THE HIDDEN *CPU* LOGO ON OUR COVER?

Gotcha. Here it is.

EKWB Announces Fluid Gaming Kits

EKWB has a new line of cooling kits called Fluid Gaming. According to EKWB, initial cost is one of the main obstacles keeping people from building custom loops in their systems. EKWB's solution was to create new technology to build high-quality waterblocks at volume out of aluminum, which is much less expensive than copper. The kits combine new aluminum waterblocks with a high-quality aluminum radiator, efficient pump, tubing, and Vardar fans, along with all the necessary fittings for a custom loop. The new technologies and production efficiencies allow the company to sell the expandable new custom loop kits at about the same price as a closed-loop AIO kit. The Fluid Gaming line launched with three kit models: the A120 ($149.99), the A240 ($159.99), and the A240G ($239.99). The names indicate radiator sizes. The A120 and A240 come with a CPU waterblock, while the A240G kit also includes a custom block for NVIDIA GeForce GTX 10 series graphics cards.

ZOTAC Claims It Has The World's Smallest 1080 Ti Graphics Card

ZOTAC says its new GeForce GTX 1080 Ti Mini is the world's smallest card that carries NVIDIA's 1080 Ti GPU. The new card measures just 8.3 inches in length (211mm). The two fans in the IceStorm cooler are different sizes (90mm and 100mm). The smaller fan has wide fan blades that are flat to push the maximum amount of air, while the larger fan has curved blades designed for higher static pressure. The cooler includes a copper direct contact plate, five 6mm copper heatpipes, and an aluminum heatsink. The Mini has base/boost clocks of 1,506MHz/1,620MHz and carries 11GB of GDDR5X memory. The dual-slot card has a gunmetal gray color scheme. There's a metal backplate with ZOTAC logo (in the same gunmetal gray), and the card has white LED lighting. The ZOTAC GeForce GTX 1080 Ti Mini is now available and retails online for about $520.

WATCHING THE CHIPS FALL

Here is the pricing information for various AMD and Intel CPUs.

CPU	Released	Original Price	Last Month's Price	Online Retail Price*
AMD Ryzen 7 1800X (Zen)	3/2/2017	$499	$464.99	$459.99
AMD Ryzen 7 1700X (Zen)	3/2/2017	$399	$389.99	$349.99
AMD Ryzen 7 1700 (Zen)	3/2/2017	$329	$314.99	$309.99
AMD Ryzen 5 1600X (Zen)	4/11/2017	$249	$249.99	$239.99
AMD Ryzen 5 1600 (Zen)	4/11/2017	$219.99	$219.99	$214.99
AMD Ryzen 5 1500X (Zen)	4/11/2017	$189	$189.99	$189.99
AMD Ryzen 5 1400 (Zen)	4/11/2017	$169	$169.99	$169.99
AMD A10-7890K (Godavari)	3/1/2016	$164.99	$149.99	$149.99
AMD Athlon X4 880K (Godavari)	3/1/2016	$94.99	$79.99	$91.85
AMD Athlon X4 845 (Carrizo)	2/2/2016	$69.99	$52.37	$69.43
Intel Core i7-6950X (Broadwell E)	5/31/2016	$1,723**	$1,649.99	$1,449.99
Intel Core i7-5960X Eight-Core (Haswell)	8/29/2014	$999**	$1,009.95	$1,009.95
Intel Core i7-6900K (Broadwell E)	5/31/2016	$1,089**	$1,049.99	$899.99
Intel Core i9-7900X 3.3GHz (Skylake X)	6/26/2017	$999.99**	n/a	$999.99
Intel Core i7-7820X 3.6GHz (Skylake X)	6/26/2017	$599.99**	n/a	$599.99
Intel Core i7-6850K (Broadwell E)	5/31/2016	$617**	$609.99	$479.99
Intel Core i7-7800X 3.5GHz (Skylake X)	6/26/2017	$389.99**	n/a	$389.99
Intel Core i7-7740X 4.3GHz (Kabylake X)	6/26/2017	$349.99**	n/a	$349.99
Intel Core i7-6700K Quad-Core (Skylake)	8/5/2015	$359**	$339.99	$339.99
Intel Core i5-7640X 4.0GHz (Kabylake X)	6/26/2017	$249.99**	n/a	$249.99

* As of June 2017
** Manufacturer's estimated price per 1,000

Corsair K68 Keyboard Is Built To Handle The Hazards Of LAN Gaming

Corsair has a new mechanical gaming keyboard that's aimed at klutzy gamers. Well, not exactly. The Corsair Gaming K68 keyboard is designed to be extra resistant to liquid spills so you can keep gaming even when you accidentally tip your drink over on your plank. The K68 features Cherry MX Red keyswitches with 100% antighosting and full-key rollover. A silicone rubber shielding protects every key from the elements, including dust and spilled drinks. Each key also has dynamic backlighting from red LEDs. The keyboard has dedicated multimedia and volume controls, and it works with CUE (Corsair Utility Engine) software, which lets you create custom macros and lighting effects. The Corsair Gaming K68 is a tough plank that's built to take the rough and tumble of gaming sessions. The keyboard is available immediately at retailers. You can find it online for about $70.

Thermaltake Unveils Floe Riing Premium Edition Liquid Coolers

Thermaltake has a new series of premium liquid coolers on the way. The new Floe Riing RGB TT Premium Edition Series features high-quality components and supports RGB customization. The new CPU coolers come in 240mm, 280mm, and 360mm radiator sizes and are cooled with the company's eye-catching Riing RGB fans. Thermaltake says the rads support up to four 120mm, four 140mm, or six 120mm fans. The waterblock has a copper base and six LEDs and is adorned with a new Thermaltake logo that the company developed for the TT Premium brand. The logo lights up in sync with the Riing fans. The cooler comes prefilled with coolant, and a high-powered pump ensures maximum water flow. Thermaltake says sleeved cabling protects the low-evaporation tubing, and the entire product is designed to be easy to use and maintenance-free.

AORUS X299 GAMING Motherboards Are Ready For X-Series Processors

GIGABYTE has three new motherboards under its AORUS brand: the X299 AORUS GAMING 3, X299 AORUS GAMING 7, and the flagship X299 AORUS GAMING 9. All three motherboards sport the new Intel X299 chipset and socket LGA 2066 that form the basis of support for Intel's new X-Series processors. The boards feature a black PCB and a black baseplate that provides additional support for heavy components. Armor plating provides additional reinforcement and protection. The boards include GIGABYTE's Smart Fan technology, and Hybrid Fan Pin Headers on the board support liquid-cooling sensors for flow rate and water temperature. The top-of-the-line GAMING 9 supports triple M.2 sockets, and M.2 Thermal Guard helps reduce temperatures. Mobo MSRPs are $499.99 (GAMING 9); $399.99 (GAMING 7); and $279.99 (GAMING 3).

ENERMAX Touts GraceMesh Chassis

ENERMAX designed GraceMesh to help cool high-performance systems. The case includes mesh paneling on the front and top, and the interior is laid out in a way that maximizes airflows. There are positions in the case to accommodate up to seven fans (two 140/120mm up front; two 120mm on top; one 120mm in the rear; and two 120mm to cool the PSU). For those who prefer liquid cooling, the chassis supports dual radiators (240/280mm) on the front and top as well as one 120mm in the rear. The power supply and cabling in the GraceMesh can be hidden behind a PSU shroud. A large 4mm tempered-glass panel lets you show off interior components. The case supports graphics cards up to 390mm long and CPU coolers up to 156mm tall. There are two 5.25-inch and two 3.5-inch drive bays. The 3.5-inch HDD trays can also support 2.5-inch SSDs, so there are spots for up to five SSDs. The case comes in one color, black, and can accommodate ATX/microATX/Mini-ITX motherboards.

HARDWARE MOLE

## Curved ROG Swift PG35VQ Offers G-Sync & 200MHz Refresh Rate

The ROG Swift PG35VQ from ASUS is a gaming display with a huge 35-inch curved screen and 21:9 aspect ratio. The company says the new display offers UWQHD resolution (3,440 x 1,440) at up to three times the brightness of the typical monitor. The screen also can produce deep blacks, with 512 LEDs that can be turned off individually for localized dimming. Colors are vibrant, too, thanks to quantum dot technology. Gamers will appreciate the raw speed of the ROG PG35VQ. The display supports NVIDIA's G-Sync, and it has a maximum refresh rate of 200MHz. For additional fun, the largest gaming screen in the ASUS stable has RGB lighting that works with the ASUS Aura Sync control system.

FSP Shows Off New Hydro PTM+, A Liquid-Cooled Power Supply

FSP Group has created a liquid-cooled power supply called the Hydro PTM+. FSP says it designed the new power supply with the help of liquid-cooling experts at Bitspower. The new PSU is certified 80 PLUS Platinum and is rated at 1,200W before the liquid cooling is activated. With the liquid-cooling system running, FSP says the power rating of the Hydro PTM+ reaches 1,400W. The company says the PSU is so efficient, it is able to crank out 600W in "silent mode" (without the fan running). The unit's fan only activates when the PSU is at 50% or more load. Along with the liquid cooling, the Hydro PTM+ also features LED lighting. There is no word yet on availability or pricing.
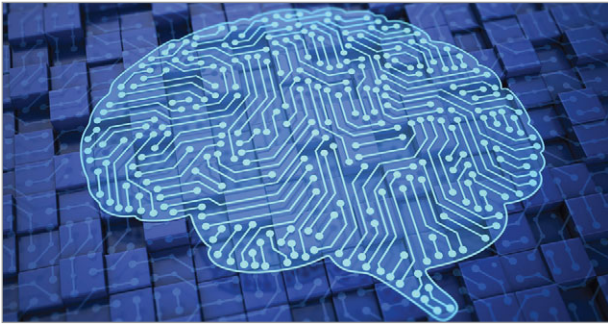
New Research Looks At Longer-Term Effects Of Violent Videogames

Most recent research has looked at the acute, short-term impacts of videogames, but a group at Germany's Hannover Medical School looked into the long-term effects, according to their research paper. The use of violent videogames has been linked to more aggressive behaviors, the researchers note, attributed to the emotional desensitization process that comes from repeatedly playing the games. Researchers looked at 15 excessive users of violent videogames, who were matched with control subjects based on age and education. Participants viewed pictures depicting emotional and neutral situations with and without social interaction while undergoing a functional MRI. Both groups showed typical patterns of activations for empathy and theory of mind, but there were no differences in brain responses, or in empathy or aggressiveness, between the groups. More research is needed, but based on these results, the researchers note, the impact of violent media on emotional processing could be acute and short-lived.

Games Category Generates Most First-Time $1 Million App Publishers

Based on an analysis it ran on in-app revenue, Sensor Tower reports that last year nearly twice as many publishers earned their first $1 million in annual revenue via Apple's U.S. App Store than via Google Play. Overall, Sensor Tower reports that 66 publishers made their first $1 million or more in 2016 on Apple's platform, which compares to the 39 publishers who did the same via Google Play. Sensor Tower also analyzed the app categories that publishers focused on to make their first $1 million. The Games category generated the most publishers earning their first $1 million on both platforms, but far more publishers did so on Google Play (75%) than the App Store (45%). The U.S. App Store, Sensor Tower reports, saw first-time $1 million earners coming from a broad group of categories, including Social Networking, Entertainment, and Lifestyle. On Google Play, only the Social Networking (5%) and Entertainment (5%) categories topped the 5% mark.

SOFTWARE SHORTS

The Way You Walk Could Be Your Next Password

Researchers around the world are on a quest for the next great security authentication technique that's more difficult to circumvent yet easier to use. Gait recognition, combined with kinetic energy harvesting, or KEH, is showing signs of promise. Researchers at Australia's CSIRO have combined the two technologies in a wearable device that can capture a user's gait in terms of both motion and velocity while also translating motion into electrical energy that improves the battery life of the wearable, researchers report.

In a test of KEH-Gait, the researchers gathered data on 20 users with different settings and various environments. In the trial, KEH-Gait accurately authenticated users 95% of the time and reduced energy consumption by 78% compared to current accelerometer-based authentication techniques, the researchers note. Simulated "attackers" attempted to imitate a user's motions to access the system; 13 of 100 imposter trials were accepted as genuine.

Professor Dali Kafaar said the KEH-Gait system is convenient because a person's gait can be continuously sampled and verified. It's also more secure than passwords, he said. "Since the KEH-Gait keeps authenticating the user continuously, it collects a significant amount of information about our movements, making it difficult to imitate or hack, unlike guessing passwords or PIN codes."

Internet User Growth Is Slowing, Ads & E-commerce Are Accelerating

The growth rate in the number of global internet users is staying relatively flat, global smartphone shipments are slowing down, online advertising continues to grow, and gaming is a large and growing business. Those are among the findings in the Internet Trends 2017 report from Kleiner Perkins Caufield & Byers Partner Mary Meeker. There's little surprise in the four biggest technology companies (Apple, Google, Amazon, and Facebook) or the report's findings about the internet population—growth has been flat at about 10% a year for the past five years, with about 3.4 billion internet users globally, which is more than double the number since 2009. Internet advertising and e-commerce, on the other hand, both showed solid growth. In the United States, online advertising was up 22% last year. Gaming is becoming big business, reaching more than $100 billion in revenue last year. There are now more than 2.6 billion gamers worldwide, up from about 100 million in 1995.

New Technology Aims For LTE Benefits With Wi-Fi Simplicity

Industry leaders from Qualcomm, Nokia, Ericsson, Intel, and other major corporations are working to alleviate the strain on network capacity caused by our ever-increasing reliance on wireless connectivity. If the group is successful, it will bring about a new era where mobile networks are as simple to deploy as today's Wi-Fi networks but have the performance benefits of LTE technology. Dubbed MulteFire, the technology makes it possible to deploy a standalone LTE network in unlicensed or shared spectrum. That means virtually anyone can create, install, and operate his own private or neutral-host MulteFire network, according to the MulteFire Alliance. The alliance notes that MulteFire isn't expected to replace

either LTE or Wi-Fi; instead, the technology can enhance or work with Wi-Fi and LTE to improve coverage, quality, and compatibility. Qualcomm, which is helping to create MulteFire, notes that the ultimate goal of the technology is to ensure the best possible user experience for wireless access to the internet or when making voice/video calls, especially in hyper-dense environments. Release 1.0, version 1.0.1 is now publicly available, and release 1.1, with additional IoT optimizations, is expected later this year.

SITE SEEING

Chrome To Support Better Ads Standards

Google is working with the Coalition for Better Ads—a group of international trade associations and online media companies—in its effort to improve the online advertising experience. The coalition recently studied the online experiences of more than 25,000 consumers to identify the ad experiences that rank lowest and cause users to adopt ad blockers, it states. Based on that research, the

coalition released its Better Ads Standards, which outlines four types of desktop web ads and eight types of mobile web ads that "fall beneath a threshold of consumer acceptability," the group notes. In a blog post announcing Google's work with the coalition, Sridhar Ramaswamy, Google's senior

vice president for ads and commerce, said that "frustrating experiences can lead some people to block all ads—taking a big toll on the content creators, journalists, web developers, and videographers who depend on ads to fund their content creation."

To give users "the best possible experience browsing the web," Ramaswamy said, Chrome will stop showing ads (even those served by Google) on websites that don't comply with the Better Ad Standards starting early next year. Google also released an Ad Experience Report to help websites understand how Better Ads Standards applies to them and how to fix any issues they find. These efforts, Ramaswamy said, will "ensure all content creators, big and small, can continue to have a sustainable way to fund their work with online advertising."

Job Of The Month

One of the most recognizable corporate names in the U.S. is Harley-Davidson, the company with the namesake founders who created a motorcycle that became a cultural icon. After more than a century, Harley-Davidson is still cranking out road machines, and now it's looking to add a senior database analyst at its offices in Valley View, Ohio. This person will be responsible for implementing and maintaining critical RDBMS systems in an SQL Server Warehouse and also will have a hand overseeing the company's ERP software. HD wants someone with a degree in comp sci, math, or a related field, and at least five years' experience working with SQL Server. If you're a Microsoft Certified Database Administrator, all the better. You should know your way around modeling, data warehousing, performance tuning and optimization, and Active Directory. HD offers a range of benefits, including (yup) product discounts. Fill out an app at the company's website and pick up a hog, Mr. Database Guru.

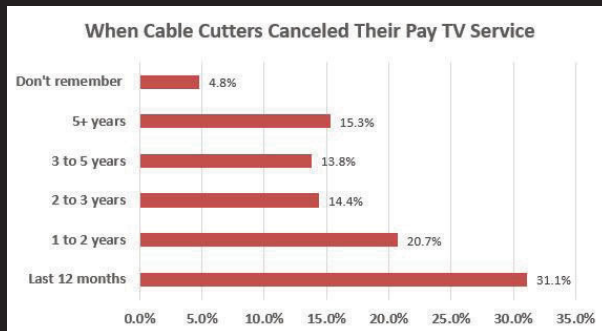*Source: jobs.harley-davidson.com*

We Like Our Toys

Digital products such as computers and smartphones have become staples in the typical American household. Surveys conducted by Pew Research show that more homes have a cell phone than a landline, and many homes have multiple digital products. More than a third of Americans live in households with three or more smartphones, and half of American homes hold five or more

Percentage Of U.S. Households That Have The Following Tech Devices

Device	Percentage
STREAMING MEDIA DEVICE	39%
TABLET	68%
DESKTOP/NOTEBOOK COMPUTER	80%
SMARTPHONE	84%
ANY OF THE ABOVE	90%

mainstream digital devices (computer/smartphone/tablet/streaming media device). Some households are permeated with digital products. Nearly one in five households (18%) contain 10 or more digital devices, a condition that Pew refers to as "hyperconnected." At the other end of the spectrum, Pew reports that 10% of survey respondents say they have no digital devices in their homes.

Source: Pew Research Center
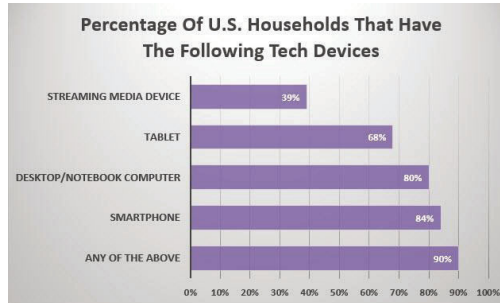
So Long, Cable Companies; Hellllooooo, Netflix!

First it was millennials with cell phone service getting rid of their landlines, now it's people of all ages with internet service saying "See ya!" to their cable TV companies. With a growing range of alternative video-viewing options (Netflix, Hulu, Sling, YouTube, AmazonTV, and so on) the number of people opting out of traditional television cable services continues to grow. According to the report "Life Without Legacy Pay-TV: A Profile Of U.S. Cord Cutters And Cord Nevers" by research firm TDG (The Diffusion Group), the cord-cutting trend is accelerating.

When Cable Cutters Canceled Their Pay TV Service

Period	Percentage
Don't remember	4.8%
5+ years	15.3%
3 to 5 years	13.8%
2 to 3 years	14.4%
1 to 2 years	20.7%
Last 12 months	31.1%

Surveys by TDG showed that half of all cable cutters had decided to cut off their cable service in just the past two years, with nearly a third making the move in just the past 12 months. Time to binge watch with some popcorn.

Source: The Diffusion Group

40

The percentage increase in Wi-Fi data usage last year by U.S. households with smartphones. Research by Parks Associates shows that the popularity of Wi-Fi continues to grow and that more than three-fourths of U.S. households with broadband connections use Wi-Fi.

Parks Associates

44

The percentage of consumers in Asia and in the Pacific who use mobile shopping apps. Research from Gartner shows that a higher percentage of consumers in the Asia-Pacific region use the apps than in any other area in the world.

Gartner

57

The percentage of websites that collect visitors' email addresses, according to a 2017 website security survey by the business services company Clutch. The survey found that websites also collect user's names (47%) and locations (45%).

Clutch

62

The percentage of people aged 13 to 24 who say they or someone close to them have been the victims of cyberbullying. The information was gathered as part of a survey by ReportLinker on how cyberbullying affects people's lives.

ReportLinker.com

AMD Sells Out

Radeon RX 570 & 580 Roundup

People often ask us about the best time to buy a new graphics card. Our usual response is, if you can be patient, you should wait a couple months after a new graphics card launch to give product supply time to stabilize, to ensure that there are lots of choices available from the chipmaker's AIB (add-in board) partners, and to give the competing chipmaker a chance to drop prices. As we went to press, however, none of the cards we tested for this roundup could be found at retail—but not for any of the typical reasons.

A Crypto-Mining Hiccup

Earlier this month at Computex, we met with graphics card vendors SAPPHIRE, MSI, GIGABYTE, and ASUS, and although there wasn't much in the way of new products to discuss, each representative seemed extremely pleased with how well the Radeon RX 500 Series cards, particularly the RX 570 and RX 580, were selling. (Radeon RX 400 Series cards are also widely unavailable.) By now you're probably aware of history repeating itself with the recent scarcity of graphics cards prompted by a boom in home-based Ethereum mining, an upstart blockchain-based distributed "smart contract" computing platform that looks and sounds very much like a cryptocurrency. When we were writing about the Bitcoin home mining phenomenon in April 2014, the bottom was just falling out on the hash rate for consumer-grade graphics cards, though gamers in the market for a Radeon R9 200 Series card would have to wait a few more months before prices and supply stabilized. It looks like we're going through another such

PULSE Radeon RX 570 4GD5
$169.99 | SAPPHIRE | pulse.sapphiretech.com

disruption that is putting a smile on the faces of graphics card vendors, but is a bit of a downer for gamers seeking affordable gear.

As with all other cryptocurrencies, the amount of GPU power it takes to mine will increase as the pool of miners grows, the complexity of the calculations ramps up on a predetermined schedule, ASICs (application-specific integrated circuits) may eventually deliver dramatically improved hash rates compared to graphics cards, and the price of Ethereum may simply deflate to the point that powering a mining rig becomes unprofitable. Furthermore, AMD's AIB partners are

aware of the demand, and you can bet they're doing everything they can to churn out as many cards as possible. (For what it's worth, several of them told us that they would rather their cards were purchased by gamers.) All of this means that the shortage of Radeon RX 500 Series cards won't last forever, and the following series of reviews will help you ultimately make a more informed decision when choosing your next graphics card.

Under The Heat Spreader

The graphics cards in the Radeon RX 500 family use AMD Polaris GPUs that are essentially overclocked versions of those used in the RX 400

CPU RANKING   0 = ABSOLUTELY WORTHLESS   2.5 = ABSOLUTELY AVERAGE   5 = ABSOLUTELY PERFECT

HEAVY GEAR
3.5 OUT OF 5
CPU

Radeon RX 570 GAMING X 4G
$175 | MSI | us.msi.com

Series. As such, this is the fourth-generation GCN (Graphics Core Next) architecture, highlighted by an overhauled geometry engine. Games that support high levels of MSAA (multisample anti-aliasing) will get 2x to 3.5x improvement in tessellation performance thanks to the Primitive Discard Accelerator's ability to dramatically streamline the process of culling triangles that have zero area in the final output. The engine also supports a small, instanced geometry index cache, which makes more efficient use of internal bandwidth. Shader efficiency gets a boost thanks to Polaris' reduced pipeline stalls, increased per-wave buffer size, improved L2 cache behavior, and native support for FP16 and Int16 operations. A better hardware scheduler, improved instruction prefetch, and refined memory compression technology all help the GPUs inside RX 500 Series graphics cards trounce those based on AMD's

2nd gen (RX 300 Series) and 3rd gen (R9 Fury, R9 285) GCN in terms of power/performance. Also included under the hood are new display and multimedia engines, with native support for HDMI 2.0b, DisplayPort 1.4 HBR3/HDR10, H.265 Main10 decode at 4K and 60Hz, and HDCP 2.2.

The Polaris 20 GPU inside the RX 580 and the cut-down version in the RX 570 owe much of their power efficiency to the 14nm FinFET manufacturing process. This Samsung technology, licensed to GlobalFoundries, has resulted in a graphics processor that features 5.7 billion transistors on a 232mm2 die. The old RX 470 and RX 480 are 120-watt and 150-watt TDP cards, respectively, but because the clock speed is the sole differentiator, it should come as no surprise that the TDPs of the RX 570 and RX 580 have shifted upward to 150 watts and 185 watts. The RX 580 features 36 compute units, 2,304 stream

processors, 144 texture units, and 32 ROPs. The RX 570 loses access to four of the Polaris 20's compute units, giving it a total of 2,048 stream processors, 128 texture units, and 32 ROPs.

There are 4GB and 8GB GDDR5-enabled RX 580s and RX 570s, but we only tested RX 580s with 8GB of GDDR5 and RX 570s with 4GB of GDDR5. The reference design base pricing for these cards is set at $229 and $169, respectively. Generally speaking, the amount of memory installed on the card won't have a huge impact on the benchmark scores unless the particular title is memory limited, and even at 4K, our benchmark numbers don't indicate that the 4GB frame buffer is handicapping the RX 570s we tested. As such, we'd have no trouble recommending the RX 570 8GB card, priced at right around $200. Your average framerates will be a little bit lower, but your gaming experience will degrade massively if that 4GB frame buffer ever becomes a bottleneck. Cards built with either GPU feature a 256-bit memory bus, however, the RX 580 has a memory bandwidth edge with its 8Gbps memory compared to the RX 570's 7Gbps memory.

The Radeon RX 570 reference design features base and boost clocks set to 1,168MHz and 1,244MHz, respectively. Compared to the RX 470, that's about a 26% increase on the base clock and a 3% increase in the boost clock. The flagship Radeon RX 580's base and boost clocks are 1,257MHz and 1,340MHz, which are approximately 12% and 6% higher than the RX 480's respective clocks. Of course, we recognize that 26% and 12% increases in clock speeds are unlikely to result in double-digit FPS increases in modern games. If you already own a Radeon RX 400 Series card, the 500 Series has nothing to offer, but if you're running a two-year-old or older graphics card—and by AMD's count, there are 500 million of you—you'll enjoy a substantial improvement from just such an upgrade.

CPU RANKING   0 = ABSOLUTELY WORTHLESS   2.5 = ABSOLUTELY AVERAGE   5 = ABSOLUTELY PERFECT

Despite the rebranding, many of the AIB manufacturers have taken the opportunity to release new designs, improve cooling, and tweak fan behavior to deliver better-looking and superior-performing graphics cards. If you were tempted to upgrade before, the RX 500 Series is everything we love about the 400 Series, just better.

SAPPHIRE PULSE
Radeon RX 570 4GD5

The heatsink shroud on both the PULSE RX 580 and RX 570 cards we tested is identical, and outwardly, your only clue that they're different cards is by counting the heatpipes bulging from the heatsink near the PCIe pinouts. The PULSE RX 570 has two heatpipes visible, while the PULSE RX 580 has three. The shroud consists of a piece of molded black plastic peppered with the series of indentations. This cooler's shroud looks very similar to that on SAPPHIRE's NITRO+ RX 480 and 470 cards. The backplate on the PULSE cards is a black, red, and gray-painted slab of aluminum. If you'd rather have a red or blue heatsink shroud, or maybe even some translucent fans with colored LEDs, SAPPHIRE's NITRO Gear accessories make changing the look of the card fast and easy.

This is the Dual-X cooler, which is a clear reference to the pair of 95mm dust-repelling dual ball bearing fans installed on top of the heatsink. The aforementioned heatpipes are 6mm in diameter each and they're threaded through a rather traditional heatsink composed of aluminum fins. There's a substantial square of copper that resides between the top of the GPU and the heatpipes to quickly transfer heat away, and that's set into a larger nickel-plated baseplate that covers the card's memory around the GPU. On the PCB, SAPPHIRE has used high-quality components designed to minimize coil whine and deliver consistent, reliable performance for a very long time.

AORUS Radeon RX570 4G
$189.99 | GIGABYTE | www.aorus.com

This card relies on a single 8-pin PCIe power port, and its TDP is 180 watts, which you'll remember is 30 watts higher than AMD's reference design. That means you can expect a factory overclock to account for the hefty power draw; SAPPHIRE raised the boost clock to 1,284MHz, but the 4GB of GDDR5 memory remains clocked at the standard 1,750MHz. There are just four phases to the VRM on this card, but that's more than enough to keep steady, clean power supplied to the GPU for as long as you use the card. Those with overclocking ambitions should probably seek out the NITRO+ card reviewed in this roundup that's purpose-built with overclockers in mind, or at least take it easy with the core clock and voltages.

The back bracket of the PULSE RX 570 features two DisplayPort, one DVI, and two HDMI outputs. Although the RX 470 wasn't considered a "VR Ready" graphics card, the higher clocks on the 570 bridge the gap, and those two HDMI ports are a godsend for those with VR equipment.

At just a hair over 9 inches long, this is one of the most compact RX 500 series cards we tested, which makes it ideal for SFF or cramped cases. Its performance in our benchmarks put it right on par with the AORUS RX570 from GIGABYTE, but you'll pay $20 more for that card. If you're rocking a 1,920 x 1,080 monitor, then this card is more than capable of letting you max out the settings of even the most demanding games while still enjoying a better than 60fps experience.

MSI Radeon RX 570 GAMING X 4G

The MSI Radeon RX 570 GAMING X 4G is the first of the new cards we tested, and we were rather impressed that this sub $200 card performs a lot like the stock-clocked RX 480 from last year. MSI's nigh-iconic TWIN FROZR VI cooler and custom seven-phase VRM-based PCB give the GPU a lot more space to run

CPU RANKING   0 = ABSOLUTELY WORTHLESS   2.5 = ABSOLUTELY AVERAGE   5 = ABSOLUTELY PERFECT

HEAVY GEAR
4.5 OUT OF 5
CPU

PULSE Radeon RX 580 8GD5
$229.99 | SAPPHIRE | pulse.sapphiretech.com

wild, however, so the OC Mode clock (enabled via the MSI Gaming App) can boost the core to up to 1,293MHz and the memory clock to up to 7,100MHz.

All of MSI's GAMING X series graphics cards look roughly the same. But the RX 570 is a 150-watt card, so it doesn't make sense to install the same heatsink that MSI uses for the GeForce GTX 1080 or even the RX 580. On this slightly slimmed-down version of the TWIN FROZR VI, you'll find one 8mm and one 6mm heatpipe that converge over a copper plate on top of the GPU's heat spreader, and both the heatpipes and copper plate sport a nickel-plated finish. There's no backplate or PCB face plate like on MSI's higher-powered cards, but the same red and black heatsink shroud with red LED highlights is here and an RGB MSI dragon logo adds some extra visual appeal. The aforementioned Gaming App lets you tweak the LED behavior, and for those who want to push the clocks higher, MSI's Afterburner

software is one of the best Windows-based overclocking utilities we've used.

The large, 95mm double-ball bearing TORX 2.0 fans on this card feature two types of blades, with matte-textured traditional blades connected low on the hub alternating with bulging blades with a glossy stripe mounted higher on the hub. These "dispersion blades" accelerate airflow without increasing noise output, for 22% more air pressure than fans with traditional blades. MSI's ZeroFrozr technology keeps the fans motionless until the GPU is under load.

Power comes to the card via a single 8-pin PCIe power port and display outputs on the back bracket include two HDMI, two DisplayPort, and one DVI ports.

If you're looking to max out the settings on all of your games at 1080p, the MSI Radeon RX 570 GAMING X 4G will more than get you there. The 4GB frame buffer is too small for reliable 1440p gaming, though less demanding games will look great at this resolution.

GIGABYTE AORUS
Radeon RX570 4G

This card features a 1,295MHz core clock, which you can enable by installing the AORUS Graphics Engine and choosing OC Mode (Gaming Mode, the default setting, sets the clock to 1,280MHz). In order to support this frequency and remain cool and quiet under load, GIGABYTE has a number of tricks up its sleeve. First of all, the firm sorts the GPUs it gets from AMD and NVIDIA and only installs those that support high clocks with only minor leakage into its factory-overclocked products, like those under the AORUS brand. The card also features GIGABYTE's Ultra Durable components, such as a 2oz. copper PCB, solid capacitors, metal chokes, lower RDS(on) MOSFETs, and tier 1 memory.

The other main attraction is the custom AORUS air cooler, which consists of a black plastic heatsink shroud with orange highlights and adjustable RGB LEDs, an aluminum heatsink threaded with a quartet of GIGABYTE's composite copper heatpipes that make direct contact with the surface of the GPU's heat spreader, and a brushed-aluminum backplate with a copper square over the backside of the GPU to assist in transferring heat from the center of the card as quickly as possible. Two 90mm fans, with unique airflow-optimizing grooved blades, spin in opposite directions to cover more of the heatsink with cool air.

On the back bracket of the AORUS RX 570 4G, you'll find three DisplayPort, one HDMI, and one DVI outputs. There's an 8-pin PCIe power connector on the top edge of the card, which, together with the 6+1 phase VRM should be enough to let you eke that core clock up even higher using the AORUS Graphics Engine.

In addition to all of the above, we like how compact this card is; it measures less than 9.25 inches long, and the air cooler only extends a quarter-inch above the top edge of the PCB. Its performance in our benchmarks put it only a few frames

CPU RANKING   0 = ABSOLUTELY WORTHLESS   2.5 = ABSOLUTELY AVERAGE   5 = ABSOLUTELY PERFECT

per second behind a handful of the RX 480s we tested just six months ago and late last year. If you're committed to a 1080p gaming experience, the AORUS RX 570 4G will let you max out the settings in virtually any game. For less than $200, that's no small feat.

SAPPHIRE PULSE
Radeon RX 580 8GD5

There are a lot of shared components between the PULSE RX 570 and 580. One thing that is not shared, however, is the boost clock, which is set to 1,366MHz, and as such, its TDP is a stout 225 watts. The memory is again left at the stock setting, but for the RX 580 that's a speedy 2,000MHz. That said, the 8-pin PCIe power port is still more than enough to supply this card with the requisite juice.

The black plastic Dual-X cooler shroud is the same as on the PULSE RX 570, but the heatsink underneath is larger, with more 6mm copper heatpipes, and as a result, it's considerably more capable. The nickel-plated base plate that covers the memory chips surrounding the GPU is about twice as thick as the one on the PULSE RX 570. The two 95mm fans here are also the dust-resistant dual-ball bearing variety. With the Quick Fan Connect feature, you can easily swap out these fans by removing a single screw in the unlikely event that these long-life fans ever give you trouble. The aluminum backplate is a nice bonus for what's essentially a budget card, adding to its rigidity and helping to improve cooling.

The PCB on this card is identical to that of the PULSE RX 570, save for the extra 4GB of GDDR5 (for 8GB total) and the fully unlocked Polaris 20 GPU. Outputs include two DisplayPort, two HDMI, and one DVI.

The four extra compute units we mentioned earlier account for a fairly decent performance difference in the benchmarks. AMD is happy to call the RX 580 a viable option for gamers running 2,560 x 1,440 resolution displays, though SAPPHIRE seems

AORUS Radeon RX580 XTR 8G
$279.99 | GIGABYTE | www.aorus.com

to acknowledge that there are some instances where settings need to be dialed back to reach that 60fps sweet spot. To us, this is just one of many indications of just how high SAPPHIRE's standards are, and it's a big reason why we're fans of the products they create. The PULSE Series are essentially factory-overclocked reference design cards, built to a higher standard, but without a higher price tag.

We gave an extra half-point to this card, largely due to the 8GB frame buffer, which will keep this card in better stead as future game titles release. That said, the $60 price difference between the PULSE RX 570 and the PULSE RX 580 is substantial enough that we have no problem recommending both to gamers on a tight, or slightly less-tight budget, respectively.

GIGABYTE AORUS
Radeon RX580 XTR 8G

Between the two AORUS cards in this roundup, the AORUS RX 580 XTR 8G is the decidedly more capable one. The OC Mode core clock here is set to 1,439MHz, and without flipping the switch in the AORUS Graphics Engine software, the card runs at 1,425MHz. As mentioned above, this card benefits from GIGABYTE's "GPU Gauntlet Sorting" binning methodology, and it's also built with the same Ultra Durable caps, chokes, MOSFETs, copper-infused PCB, and tier 1 memory as the AORUS RX570.

At first glance, the cooler on the AORUS RX580 XTR 8G looks like a beefier version of the cooler on the RX570. Here we have a pair of 100mm fans and an overall card length of more than 10.5 inches. The heatsink also extends approximately three quarters of an inch above the top edge of the PCB. There's a sizeable gap between the fans, calling to mind the stacked WINDFORCE 3X heatsinks, but don't be fooled, there's no third fan hiding under that AORUS badge. Like the RX570 4G's fans, these spin in opposite directions to more

CPU RANKING   0 = ABSOLUTELY WORTHLESS   2.5 = ABSOLUTELY AVERAGE   5 = ABSOLUTELY PERFECT

NITRO+ Radeon RX 580 8GB Limited Edition
$279 | SAPPHIRE | www.sapphiretech.com

This card's gunmetal grey heatsink shroud, a color exclusive to the Limited Edition, looks familiar on the outside, but the underlying Dual-X heatsink is bigger and better, featuring four nickel-plated copper heatpipes, more robust VRM cooling, and a 54-fin heatsink. All told, the cooler lets the card run up to 12dbA quieter than the cooler on the 400 Series NITRO+ cards. Out of the box, the card features two black 95mm dual ball-bearing fans, but the Limited Edition ships with a set of frosted translucent fans with blue LEDs. It took us less than five minutes to swap them out, and the extra illumination, although not RGB, was a nice touch. The SAPPHIRE logo is RGB-controllable, however, and SAPPHIRE's NITRO Glow feature lets you vary the color by fan speed or GPU temperature, cycle through colors, or run with the static color of your choice.

The Limited Edition also has a dual BIOS switch on the top edge that lets you choose between the NITRO+ clock of 1,411MHz and the Limited Edition clock of 1,450MHz. This is clearly a binned chip, and we are pleased to report that the card remains fairly quiet under load, even when running at the higher core clock. In order to feed this card with enough juice to maintain those clocks, there are 8-pin and 6-pin PCIe power ports on the top edge of the card. Display outputs on the back bracket include two HDMI, two DP, and one DVI port.

Last year's Radeon RX 480 was capable of running our games at a playable 1440p, but only just. The NITRO+ Radeon RX 580 Limited Edition feels much more at home at this resolution. The Limited Edition extras are great for fanatics, but at $229, the vanilla PULSE RX 580 offers a lot more bang for the buck. ∎

evenly bathe the heatsink in cool air. The composite heatpipes are 6mm and 8mm in diameter, and they crisscross through a more substantial aluminum heatsink and converge over the top of the GPU's heat spreader. Portions of the 6+2 phase VRM and all of the memory chips get direct heatsink contact via metal plates and thermal pads. There are a few more adjustable RGB LEDs on this card, and the stylish AORUS badge on the front is more striking than the rather muted-looking heatsink shroud on the AORUS RX570.

A brushed aluminum backplate with a copper patch under the GPU is also bolted to the back of the card for improved cooling and added rigidity. Power comes via 8-pin and 6-pin PCIe power connectors. Outputs include three DisplayPort, one HDMI, and one DVI.

In the benchmarks, this card's impressive core clocks keep it comfortably ahead of the AORUS RX570, and the heartier cooler makes sure it remains quiet and cool all the while. When compared to the overclocked GTX 1060s we've tested, this card trades blows, though it does command a higher premium compared to RX 580s based on AMD's reference design. If you're looking for one of the faster RX 580s out there, this one is on that very short list.

SAPPHIRE NITRO+
Radeon RX 580 8GB Limited Edition
The SAPPHIRE Radeon RX 580 NITRO+ Limited Edition is everything you love about AMD's Radeon RX 500 Series, slathered in frosting and adorned with a cherry. And sprinkles.

Test System Specs: Processor: Intel Core i7-6950X; Motherboard: GIGABYTE GA-X99-Ultra Gaming; Memory: 16GB HyperX Predator DDR4-3000; Storage: 240GB OCZ Vertex 3 MAX IOPS SSD; OS: Windows 10 Enterprise

CPU RANKING   0 = ABSOLUTELY WORTHLESS   2.5 = ABSOLUTELY AVERAGE   5 = ABSOLUTELY PERFECT

Specs & Scores	SAPPHIRE PULSE Radeon RX 570 4GD5	MSI RX 570 GAMING X 4G	GIGABYTE AORUS Radeon RX570 4G	SAPPHIRE PULSE Radeon RX 580 8GD5	GIGABYTE AORUS Radeon RX580 XTR 8G	SAPPHIRE NITRO+ Radeon RX 580 8GB L.E.
Price	$179	$175	$189.99	$229	$279.99	$279
Reference clock	N/A	N/A	1,244MHz	N/A	1,340MHz	1,411MHz
Boost clock	1,284MHz	1,293MHz (OC)	1,295MHz (OC)	1,366MHz	1,439MHz (OC)	1,450MHz
Memory clock	1,750MHz	1,775MHz (OC)	1,750MHz	2,000MHz	2,000MHz	2,000MHz
Memory interface	256-bit	256-bit	256-bit	256-bit	256-bit	256-bit
Memory	4GB GDDR5	4GB GDDR5	4GB GDDR5	8GB GDDR5	8GB GDDR5	8GB GDDR5
3DMark Fire Strike Extreme	5,321	5,304	5,215	5,855	6,085	6,008
Graphics Score	5,460	5,443	5,319	6,034	6,317	6,200
Physics Score	21,037	20,605	21,217	21,035	19,203	21,108
Games	**1,920 x 1,080**					
Shadow Of Mordor (Vsync Off, Ultra, DoF, OIT, Tess)	80.49fps	83.4fps	80.29fps	89.27fps	92.65fps	95.45fps
Metro: Last Light (DX11, V High, 16XAF, V High Tess.)	78fps	78.33fps	78fps	87fps	89.67fps	89.33fps
Dying Light (High, AO On, AA On, Vsync Off)	90.03fps	91.91fps	92.18fps	105.16fps	100.81fps	103.14fps
Witcher 3: Wild Hunt (Vsync off, Unl. fps, Ultra)	60.84fps	62.02fps	66.43fps	64.21fps	72.45fps	74.97fps
	2,560 x 1,440					
Shadow Of Mordor (Vsync Off, Ultra, DoF, OIT, Tess)	57.49fps	60.01fps	57.09fps	63.48fps	65.84fps	67.78fps
Metro: Last Light (DX11, V High, 16XAF, V High Tess.)	50.33fps	50.33fps	50fps	56fps	58fps	57.33fps
Dying Light (High, AO On, AA On, Vsync Off)	63.75fps	65.17fps	61.78fps	73.2fps	71.38fps	71.3fps
Witcher 3: Wild Hunt (Vsync off, Unl. fps, Ultra)	40.61fps	45.04fps	46.28fps	44.81fps	54.74fps	52.11fps
	3,840 x 2,160					
Shadow Of Mordor (Vsync Off, Ultra, DoF, OIT, Tess)	32.12fps	32.99fps	31.66fps	35.62fps	36.96fps	37.26fps
Metro: Last Light (DX11, V High, 16XAF, V High Tess.)	25.33fps	25.33fps	25fps	28fps	29fps	28.67fps
Dying Light (High, AO On, AA On, Vsync Off)	32.88fps	33.85fps	32.59fps	35.45fps	36.74fps	36.78fps
Witcher 3: Wild Hunt (Vsync off, Unl. fps, Ultra)	22.28fps	25.45fps	24.48fps	25.97fps	32.23fps	28.48fps

CPU RANKING   0 = ABSOLUTELY WORTHLESS   2.5 = ABSOLUTELY AVERAGE   5 = ABSOLUTELY PERFECT

HEAVY GEAR
4.0 OUT OF 5
CPU

X299 AORUS Gaming 3
$279.99
AORUS
www.aorus.com

X299 AORUS Gaming 3

Processor wars are an awesome thing. The Core X-series CPUs are a big change to Intel's HEDT (high-end desktop) platform that had been relatively stagnant since 2014. The X299 chipset accompanies the Core X-series and comes with its own valuable HEDT additions. The X299 AORUS Gaming 3 is one of GIGABYTE's new X299 options. And while it's not the top-of-line AORUS board, it includes several of the amenities found on the higher-end AORUS X299 mainboards. It's also a good example of the base features you're likely to see with X299 motherboards.

Motherboard manufacturers have a lot more connectivity and I/O options with X299 than they did with X99. Intel equips the X299 chipset to handle up to 24 PCIe 3.0 lanes, 8 6Gbps SATA ports, and up to 10 USB 3.0 ports. By comparison, X99 only had access to 8 PCIe 2.0 lanes, six USB 3.0 and eight 2.0 ports, and 10 6Gbps SATA ports. The chipset's PCIe 3.0 lanes are the biggest boost. Whereas most X99 motherboards only have one M.2 port (or U.2 port), X299 motherboards can support multiple

PCIe SSDs. The X299 AORUS Gaming 3 features two M.2 ports, while the higher-end Gaming 9 and Gaming 7 models both feature 3 M.2 slots.

GIGABYTE is able to support RAID 0 and 1 configurations with PCIe SSDs on the X299 AORUS Gaming 3—without the need for Intel VROC upgrade key—because the two M.2 slots are hosted by the chipset, rather than the CPU. On the X299 AORUS Gaming 9 and 7, the third M.2 slot is hosted by the CPU and can only RAID with other PCIe SSDs using Intel VROC. If you're planning a RAID with SATA SSDs, the board supports RAID 0, 1, 5, and 10 configurations—even if they are M.2 SATA SSDs.

All of the expansion slots on the X299 AORUS Gaming 3 are PCIe x16 slots, though only two (the top and third slot) are wired for the full x16 speed. The bottom PCIe x16 slot is wired for x8 speed, while the second and fourth slots are wired for x4 speed. This layout allows for plenty of space between the true x16 slots and maximizes airflow for SLI or CrossFire configurations. 3-way CrossFire and SLI is also supported, though the slot

wired for x8 speed is next to the bottom of the PCB, and depending on your case, might require the use of a single-slot card.

If you pair the X299 AORUS Gaming 3 with a Skylake-X processor, the motherboard supports up to 128GB of quad-channel DDR4 memory over eight DIMM slots. But similar to other X299 mainboards, the X299 AORUS Gaming 3 will disable half of the DIMM slots if you install a Kaby Lake-X CPU (due to the dual-channel architecture) and limit you to four DIMM slots and 64GB of system memory. Either way, GIGABYTE says the board can work with DDR4 modules as fast as 4333MHz.

GIGABYTE continues to evolve its support for RGB LEDs with its X299 AORUS lineup. The new boards feature a WS2812 LED controller that supports digital LED strips, rings, or matrices where you can address the color and brightness of individual LEDs. As such, you can create color patterns and unique lighting effects. The X299 AORUS Gaming 3 includes one digital LED header (for 5050 digital LED strips) and two RGBW headers (for 5050 RGB or

CPU RANKING   0 = ABSOLUTELY WORTHLESS   2.5 = ABSOLUTELY AVERAGE   5 = ABSOLUTELY PERFECT
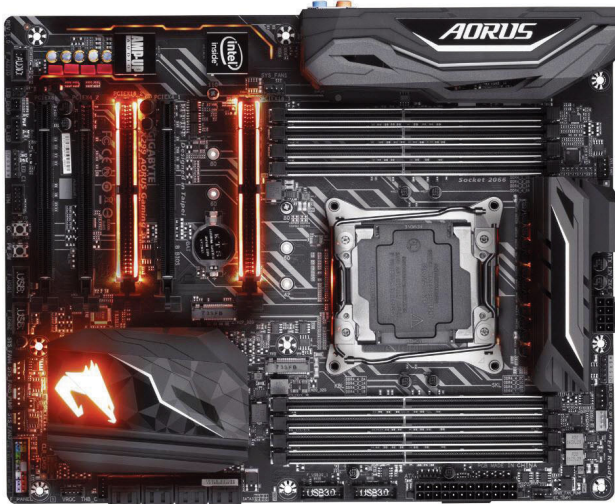
RGBW strips). You can control colors and effects for connected strips via the RGB FUSION utility and the BIOS.

The X299 AORUS Gaming 3 also features a few onboard RGB LEDs, though not nearly as many as what you'll find on the Gaming 9 and Gaming 7. For example, this motherboard lacks RGB LEDs in between the DIMM slots and the rear I/O cover, which leaves the upper portion of the board comparatively dark. It should be noted, however, that the Gaming 3 cost much less ($279.99) than the Gaming 7 ($399.99) and Gaming 9 ($499.99). The entire lineup lacks the LED strip along the right side of the board—a feature we liked on many AORUS Z270 motherboards.

To test this mainboard, we installed Intel's Core i9-7900X and 32GB of Corsair Vengeance LED 32GB DDR4-3200MHz for quad-channel memory bandwidth, while EVGA's GeForce GTX 1080 Ti FTW3 GAMING brings the graphics horsepower. The 10 core, 20 thread Core i9-7900X is put to good use in Cinebench 15 (2194 points) and POV-Ray 3.7 (4549.29 pixels per second). 3DMark's Fire Strike Extreme test displays the systems overall CPU and GPU capabilities with a Graphics Score of 14232 and a Physics Score of 24036. SiSoftware Sandra's Memory Bandwidth test (57.5GBps) demonstrates the power of X299's quad-channel support.

X299 is a big step up from the X99 chipset, but it also introduces several challenges in regards to system configuration. The X299 AORUS Gaming 3 manages to adequately support both the enthusiast class (Skylake-X) and mainstream (Kaby Lake-X) processors and other high-end hardware. The $279.99 price tag, while not cheap in relation to Z270 motherboards, is actually one of the most affordable X299 motherboards currently available. Power user wallets will need to be flush with cash to build around the Core X-series processors. ∎
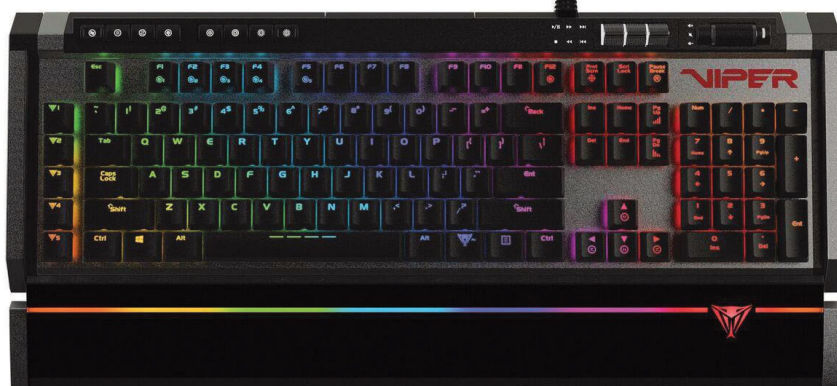
BY **NATHAN LAKE**

Benchmark Results	X299 AORUS Gaming 3
3DMark Fire Strike Extreme	13611
Graphics Score	14232
Physics Score	24036
PCMark 8	
Creative Score	6598
SiSoftware Sandra 2017 Platinum	
Dhrystone AVX2 (GIPS)	459.7
Whetstone AVX (GFLOPS)	268.4
Multi-Media Integer AVX512 x 128 (Mpixels/s)	949
Multi-Media Long-int AVX512 x64 (Mpixels/s)	1,630
Multi-Media Quad ALU x1 (Mpixels/s)	5.03
Floating B/F AVX/128 (GBps, mem bandwidth)	57.5
CrystalDiskMark 5.1.2 (MBps)	
Sequential Read (Q32T1)	525.3
Sequential Write (Q32T1)	249.3
Random 4K Read (Q32T1)	252
Random 4K Write (Q32T1)	129
POV-Ray 3.7 (Pixels/s)	4549.29
Cinebench 15 (Points)	2194
Games	(2,560 x 1,440)
Metro: Last Light (Very High, 16xAF; SSAA off)	126fps
Dying Light (High, AO On, AA On, Vsync Off)	162fps
Witcher 3: Wild Hunt (Vsync Off, Unl. FPS, Ultra)	117fps

Specs: Max memory: 128GB (DDR4-2666; Max OC: DDR4-4333); Slots: 5 PCIe 3.0 x16 (2 at x16, 1 at x8, 2 at x4); Storage: 2 M.2 (1 type 2242/2260/2280, 1 type 2260/2280/22110), 8 6Gbps SATA; Rear I/O: 2 USB 3.1 (1 Type-A, 1 Type-C), 6 USB 3.0, 1 PS/2, 1 Ethernet, audio I/O; Form factor: ATX; Warranty: 3 years

Test System Specs: Processor: Intel Core i9-7900X; GPU: EVGA GeForce GTX 1080 Ti FTW3 GAMING; Memory: 32GB Corsair Vengeance LED 32GB DDR4-3200MHz; Storage: OCZ 240GB OCZ Vertex 3 MAX IOPS SSD; OS: Windows 10 Enterprise

CPU RANKING   0 = ABSOLUTELY WORTHLESS   2.5 = ABSOLUTELY AVERAGE   5 = ABSOLUTELY PERFECT

HEAVY GEAR
4.0 OUT OF 5
CPU

Viper V770
$139.99
Patriot
patriotmemory.com

Patriot Viper V770

Patriot's Viper line of peripherals came out last year with the release of its V760 keyboard, V560 mouse, and V360 headset. The company recently augmented the lineup with some higher-end options, including the Viper V770 mechanical RGB keyboard, which has a similar layout to the V760 and has the same 16.8-million-color RGB per-key backlighting, but adds an audio pass-through port, a volume control wheel and a full set of multimedia controls, and Kailh Red mechanical keyswitches (the V760 has Kailh Brown switches).

When we talked to Patriot's VP of Product Development Roger Shinmoto for our November issue, he told us that all of these additions were a direct result of user feedback following the launch of the V760; Patriot takes its customers' suggestions seriously.

Kailh Red switches, in case you're not familiar, are linear in design, so they go straight up and straight down, having no tactile "bump" or clicky feedback. They are also among the most sensitive of mechanical switches, having a very light actuation force, and this is why they are well-suited to games like FPSes that rely on fast-twitch reflexes and precise control.

My everyday keyboard is equipped with Cherry MX Black keyswitches that are on the opposite end of the stiffness/actuation force spectrum, so it took a little time to get used to the increased sensitivity, and there were some inadvertent keypresses here and there along the way. But once you get used to Reds, they are incredibly fast and responsive, making the V770 a great keyboard for competitive multiplayer games.

Patriot gave the V770 lots of amenities, such as a detachable wrist rest, excellent macro support (you can program macros for 108 of its keys if you want to, including the five dedicated macro keys in a vertical row along the keyboard's left side), and the aforementioned full-spectrum RGB backlighting. Right out of the box, the keyboard sends waves of RGB light in alternating colors surging below the keys from left to right, but you can customize the lighting to any of 10 effects, or you can custom design your own color scheme using the V770's per-key assignable RGB lights. And, of course, you can adjust the brightness of the backlit keys or turn them all off if you want; it's entirely up to you.

It's also worth noting that the V770's wrist rest isn't the usual hard, molded-plastic throwaway part you get with some keyboards; this one has a soft-touch finish, so it's very comfy, plus it attaches to the keyboard magnetically. Oh, and it also has its own LED accent that lights up as soon as you attach it.

User profiles for the V770 are stored off the keyboard, so you can create as many as your storage device will allow. You switch profiles via the Viper software, which also lets you program individual keys (every key is programmable except for the Windows key). You can create up to five custom lighting profiles, which are stored locally on the keyboard.

Its sturdy aluminum construction and multiple rubber no-skid pads give the Patriot Viper V770 just the right amount of heft and stability; it's comfortable to use for hours at a time, it looks great, and it's highly responsive. This is one of the best gaming keyboards on the market right now, and is well worth its asking price. ∎

BY CHRIS TRUMBLE

Specs: Switch type: Kailh Red mechanical; 50 million keystroke life span; Interface: USB; Per-key RGB backlighting (16.8 million colors, 10 lighting effects); 14 light control keys; 109-key rollover; Macros: Yes (5 profiles); USB pass-through port; Game mode; Warranty: 2-year limited

CPU RANKING   0 = ABSOLUTELY WORTHLESS   2.5 = ABSOLUTELY AVERAGE   5 = ABSOLUTELY PERFECT

HEAVY GEAR
3.5 OUT OF 5
CPU

Neon K51
$44.99
Rosewill
www.rosewill.com

Rosewill Neon K51

PC component and peripheral company Rosewill has a wide range of keyboards for gamers, including several high-end mechanical models and lots of models with LED backlighting, but we recently got to look at the company's first all-white gaming keyboard, the Neon K51.

The Neon K51 also comes in black, but Rosewill sent us the white model; at a glance, it's a standard 104-key U.S. layout with a right-side numpad and a full row of function keys up top. Once you plug the keyboard into a USB port, however, you quickly see its claim to fame—and where the "Neon" in its name comes from. The second it receives power, the K51 sends undulating waves of bright, RGB lights pulsing across the entire board, from left to right, and not just beneath the keys: There's an RGB LED strip that runs around the keyboard on all four edges that is lit up in sync with the backlight under the keys.

You can set the Neon K51's backlight to one of eight color settings (Red, Green, Blue, Yellow, Sky Blue, Purple, White, and Rainbow), and you can choose among eight lighting effects, including basic static light, several cool motion effects, and a ripple effect that sends color ripples shooting across the board in every direction on each keystroke. Combined with the Neon K51's white shell, the bright LED lighting makes the keyboard stand out in a well-lit room as well as in the dark; it would be an especially apt addition to a white build with plenty of lights.

Rosewill designed the Neon K51 with "Mem-chanical" hybrid keyswitches that it says combine elements of mechanical keyswitches with traditional membrane/rubber dome switches. In our testing, the Neon K51's keys tended to feel a bit more like rubber dome keys than mechanical ones, but they are responsive and comfortable, and Rosewill says they're rated for 20 million keystrokes, which certainly takes you into mechanical switch territory.

Best of all, the move to these hybrid switches allows Rosewill to offer this keyboard at a very affordable price; the MSRP is $49.99, but Rosewill tells us that you'll find it at Newegg.com for $44.99, which is a good price for a keyboard with the K51's features.
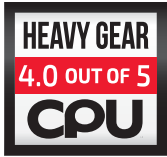
The Rosewill Neon K51 also has 19-key anti-ghosting tech, multimedia controls via its function keys, anti-slip rubber feet, and a detachable wrist rest. The keyboard is plug-and-play, doesn't require installation of any driver software, and comes with Rosewill's one-year limited warranty.

If you like the durability and responsiveness of mechanical gaming keyboards and really like RBG backlighting but don't want to pay $100 plus, Rosewill's Neon K51 presents an attractive, functional alternative that won't break the bank. ∎

BY CHRIS TRUMBLE

Specs: Switch type: Mem-chanical hybrid; 20 million keystroke life span; Interface: USB; Per-key RGB backlighting (8 colors, 8 lighting effects); 19-key anti-ghosting; Warranty: 1-year limited

CPU RANKING   0 = ABSOLUTELY WORTHLESS   2.5 = ABSOLUTELY AVERAGE   5 = ABSOLUTELY PERFECT

HEAVY GEAR
4.0 OUT OF 5
CPU

Core i9-7900X
$999
Intel
www.intel.com

Intel Core i9-7900X

The Skylake-X Intel Core i9-7900X is superior to the Broadwell-E Intel Core i7-6950X Extreme Edition in just about every way.

First, the familiar. This is a 10-core processor that can handle 20 concurrent threads at once thanks to Hyper-Threading technology. The lithography is still 14nm of Intel's Tri-Gate transistors. Now the new: The base frequency of this flagship-for-now chip is 3.3GHz, which is a decent bump compared to the Intel Core i7-6950X's 3GHz. This chip supports a Turbo Boost Technology 2.0 clock set to 4.3GHz for two cores. As long as the power and thermal limits of the system will allow, Turbo Boost Max 3.0 will single-out a pair of the chip's best-performing cores and let them run up to 4.5GHz. But the impressive speedup isn't the only way Turbo Boost Max 3.0 has improved on Skylake-X; the drivers that enable the feature are now delivered via Windows Update, so there's no need to download and install them, all the while wondering if you're getting the speed boost you paid for. We're rather impressed that all this extra power comes packed into the same 140-watt power envelope.

Between now and the last time Intel updated its HEDT processors, PCIe-based SSDs have boomed, so it makes sense that this new chip would have more to play with. There are 44 PCIe lanes from the CPU, compared to Broadwell-E's 40. The memory controller has also been updated to support DDR4-2666.

Architecturally, Intel has tweaked Skylake-X in a handful of ways. Even a casual glance at the caches and you'll notice a dramatic shift. Instead of a massive 25MB pool of shared LLC (Last Level Cache), this processor shifts all but 13.75MB to private MLC (Mid-Level Cache) accessible to each of the processor's 10 cores. This results in some single-digit percentage IPC (instructions per clock) increases, but at the cost of increased latency.

This new family of processors also comes with the AVX-512 instructions set, which is designed to improve performance for scientific simulations, financial analytics, AI, deep learning, and more. There's also support for Intel SpeedShift technology, letting the processor change P states in as little as 1ms. All told, Intel improved the front-end, made the out-of-order buffers deeper, increased the execution unit count, and raised the load/store bandwidth.

We overclocked the Intel Core i9-7900X to 4.5GHz, across all cores, with a 1.2V core voltage, for a decent bump in most scores. Any more and this chip got too hot too fast. Compared to the Broadwell-E flagship, the Intel Core i9-7900X is faster and cheaper. But with AMD's 16-core Threadripper launch imminent, and the 18-core Intel Core i9-7980XE coming later this year, this chip had better get used to living in the shadows. ∎

BY Andrew Leibman

	Intel Core i9-7900X	Intel Core i9-7900X OC
3DMark Fire Strike Ext.	13,611	13,856
Graphics Score	14,232	14,324
Physics Score	24,036	26,945
Graphics Test 1	74.82fps	76.08fps
Graphics Test 2	52.76fps	52.72fps
Physics Test	76.31fps	85.54fps
Combined Test	32.01fps	32.66fps
PCMark 8 Creative Score	6,598	6,848
Sandra 2017 Platinum		
Dhrystone Integer Native AVX2 (GIPS)	459.7	452.82
Whetstone Single-float Native AVX (GFLOPS)	268.4	302.53
x128 Multi-Media Integer AVX512 (Mpixels per second)	1,430	1,590
x64 Multi-Media Long-int AVX512 (Mpixels per second)	513.5	620.89
x1 Multi-Media Quad ALU (Mpixels per second)	5.07	5.75
x16 Multi-Media Single-float AVX512F (Mpixels per second)	1,700	684.88
Integer Memory Bandwidth B/F AVX/128 (GBps)	56.9	56.44
Float Memory Bandwidth B/F AVX/128 (GBps)	57.5	57.9
Cinebench 15 (Points)	2,194	2,412
POV-Ray 3.7 (Pxps)	4,549.29	4,839.46
Sniper Elite 4 (Vsync Off, Ultra, DX11)	166.47fps	159.76fps
The Witcher 3 (Vsync off, Unl.fps, Ultra)	129.95fps	120.01fps

Specs: Clock speed: 3.3GHz (base), 4.3GHz (Turbo Boost), 4.5GHz (Turbo Boost Max); 10-cores; unlocked multiplier; Socket R4 (LGA 2066), Quad-channel memory; 13.75MB Intel Smart Cache; Hyper-Threading; 14nm; 140W Max TDP
Test System Specs: Processor: Intel Core i9-7900X; Motherboard: GIGABYTE X299 AORUS Gaming 3; GPU: EVGA GeForce GTX 1080 Ti FTW3; Memory: 32GB Corsair Vengeance LED DDR4-3200; Storage: 240GB OCZ Vertex 3 MAX IOPS SSD; OS: Windows 10 Enterprise

CPU RANKING   0 = ABSOLUTELY WORTHLESS   2.5 = ABSOLUTELY AVERAGE   5 = ABSOLUTELY PERFECT

D.F. VEGAS & VEGAS DUO
$19.99
ENERMAX
www.enermax.com

ENERMAX D.F. VEGAS & D.F. VEGAS DUO

Modern cases with big translucent panels and LED lighting give enthusiasts much better visibility to system components than the steel behemoths of the past. And while we love the great view of power user parts, large case windows and better illumination also make it easier to see dust and debris. ENERMAX hopes to solve dirty PC problems with self-cleaning fans, such as the D.F. VEGAS and D.F. VEGAS DUO. How can a fan clean itself, you ask? ENERMAX engineers the fan to spin in reverse for 10 seconds when the system turns on to disperse dust particles on the fan blades. Once the initial spin-cycle finishes, fan rotation returns to normal operation.

Last year, we reviewed ENERMAX's first fan with DFR (Dust Free Rotation) technology, the D.F. Pressure. This high static pressure fan (up to 4.81mmH20) is designed to be used in places where the fan has to force air through tight spaces, such as next to a radiator. The D.F. VEGAS and D.F. VEGAS DUO are more suited for high airflow spots, such as front intake or rear exhaust duties. Both D.F. VEGAS models feature a 120mm, PWM-controlled fan that spins at up to 1,500rpm and generates up to 62cfm.

In addition to the DFR technology, the D.F. VEGAS lineup adds ENERMAX's circular LED illumination—featuring curved rays of light inside the fan frame. The D.F. VEGAS boasts 12 blue LEDs, while the D.F. VEGAS DUO includes both green and red LEDs. With the D.F. VEGAS DUO, you can switch between the green and red colors, or enable both sets of LEDs (perfect for Christmas time!). There are also a few effects to choose from, including a Sparkle mode where the curved LED lighting appears to be moving toward the center of the fan.

Quiet computing enthusiasts should also like that the D.F. VEGAS lineup includes ENERMAX's APS (Adjustable Peak Speed) technology where you can limit the fans' top-end rpms. Switching to the Ultra Silent mode limits PWM range from 800rpm to 1,100rpm and a maximum noise level of 18dB(A). There's also a Silent mode that sets the PWM range from 800rpm to 1,300rpm—for a maximum noise level of 20dB(A). In the Performance mode, the D.F. VEGAS max noise level is only 22dB(A) at the maximum 1,500rpm fan speed.

ENERMAX's VEGAS fans have always had style and adding the DFR technology is a just another reason to consider the D.F. VEGAS models for your next system build. At $19.99, the fans are a bit more costly than your average 120mm fan, but depending on how much you hate removing debris from your PC, the fans' self-cleaning convenience could be well worth the extra cost. ∎

BY NATHAN LAKE

Specs: Dimensions: 120 x 120 x 25mm; Speed: 800-1,500rpm (can also be set to 800-1,100rpm or 800-1,300rpm); Maximum airflow: 62cfm; Maximum air pressure: 1.9mm H20; Maximum noise: 22dB(A); Connectors: 4-pin PWM; LED: blue (D.F. VEGAS), red and green (D.F. VEGAS DUO); Current: 0.2A

CPU RANKING   0 = ABSOLUTELY WORTHLESS   2.5 = ABSOLUTELY AVERAGE   5 = ABSOLUTELY PERFECT

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HEAVY GEAR
4.5 OUT OF 5
CPU

240mm EximoSX Slim Radiator
$56.95
PrimoChill
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PrimoChill 240mm EximoSX Slim Radiator

Just as painters need the right brushes, paints, and canvas to bring their vision to life, enthusiasts need high-performance PC parts—in a variety of color options—to marry extreme overclocks and stunning creativity. PrimoChill is well-known in the power user community for its liquid-cooling and modding hardware, and the company's new EximoSX Slim Radiators come in 18 colors to make it easier than ever before to customize the look of your loop.

In this review, we take a look at PrimoChill's 240mm EximoSX Slim Radiator, yet the SX family also includes fittings, reservoirs, pump rings, coolant, and CPU blocks. A lot of cooling companies offer a few colors or metallic styles, but typically, your palette is limited to handful of options. With the SX family, PrimoChill drastically expands your color range. Just a few of the rare hues in the EximoSX Slim Radiator lineup include Candy Pink, Candy Purple, Candy Gold, UV Orange, and UV Green. There are a couple of red, black, and blue colors for those looking to complement common case, motherboard, and GPU colors.

Our test unit is a Candy Red version of the 240mm EximoSX Slim Radiator, and we also got a look at the True Blue, Sky Blue, Candy Purple, and Sky White radiators. On the Candy Red, the vivid color is complemented by a finish that adds depth and a premium gloss. Whatever color you pick, it's sure to stand out inside a build—all the more so if you pair the radiator with matching RevolverSX fittings ($39.95 for a six pack) and PrimoChill coolant (price varies by type). PrimoChill's wide color selection also gives you the flexibility to pick complementary colors, if you so desire.

The 240mm EximoSX Slim Radiator features copper and brass construction. Copper is the primary material with brass being used for tanks and side mounts. There are 14 heat transfer tubes, while the fin structure boasts 20 fins per inch—a dense tube and fin ratio. PrimoChill designs the radiator's internal core with seven dual-pass coolant lanes to help improve overall system flow and prevent loop slowdowns. The layout, according to PrimoChill, optimizes the radiator for use with low RPM fans. To maximize system compatibility, PrimoChill makes the radiator only 30mm thick.

In terms of performance, the 240mm EximoSX Slim Radiator helped to keep our AMD Ryzen 7 1800X under 72 degrees Celsius under load. Average CPU temperatures, for instance, in Prime95's SFF Torture Test were 67.4 C with a maximum of 69 C. We also ran POV-Ray for 10 minutes and CPU temperatures averaged 69.6 C with a maximum of 72 C. The results confirm PrimoChill's elite performance claims with low-noise fans, as we paired the 240mm EximoSX Slim Radiator with Aerocool's P7-12 RGB fans boasting a 1,200rpm maximum fan speed.

PrimoChill sells all colors of the 240mm EximoSX Slim Radiator for $56.95. We like that there's no upcharge for any of the more extravagant color options, such as the Candy and UV styles. The EximoSX Slim Radiator lineup goes all the way up to 480mm radiators, so you can fill up even the largest rig. With a premium appearance and performance, and a reasonable price, we find little to complain about with PrimoChill's 240mm EximoSX Slim Radiator. ∎

BY NATHAN LAKE

Specs: Materials: Brass/copper; Heat transfer tubes: 14; Dimensions: 30mm x 275mm x 120mm; Ports: 2 G/14; Fan mount spacing: 15mm; Fan thread: M3; Fins per inch: 20

Test System Specs: Processor: AMD Ryzen 7 1800X; Motherboard: MSI X370 XPOWER GAMING TITANIUM; GPU: AORUS Radeon RX580 XTR 8G; Memory: 32GB HyperX Predator DDR4-2666; Storage: 240GB HyperX FURY; OS: Windows 10 Enterprise

CPU RANKING 0 = ABSOLUTELY WORTHLESS   2.5 = ABSOLUTELY AVERAGE   5 = ABSOLUTELY PERFECT

P7-F12 Pro
$59.99 (Includes hub & 3 fans)
Aerocool
www.aerocool.us

Aerocool P7-F12 Pro

RGB LEDs are present in just about every PC component these days. And while some users might prefer to turn off LEDs entirely, we believe RGB illumination—when used creatively—can drastically improve the aesthetic appeal of a build. A big part of making RGB look artistic is coordinating colors and effects among components and fans, but this isn't always as easy as you might think. Many RGB products, for example, force you to use custom-built or proprietary controls that make it extremely difficult to match up system lighting.

The P7-F12 Pro is a kit that includes three Aerocool P7-12 RGB fans and the P7-H1, a hub where you can connect the included fans and other 4-pin RGB devices. Each P7-F12 fan features a male and female RGB 4-pin connector, which allows you to setup the fans in series—or connect another RGB 4-pin compatible device. The fan's dual RGB 4-pin design is smart, because it eliminates the need for a motherboard to have multiple RGB 4-pin headers (most don't). Aerocool indicates that P7-F12 fans work with motherboards from ASUS, GIGABYTE/AORUS, and MSI. Syncing up RGB colors and effects with the motherboard is the best way we've found to control system lighting.

Should your system's motherboard not include an RGB header, the P7-H1 features two RGB 4-pin headers, as well as five 3-pin/4-pin fan headers. A downloadable software utility is how you'll control the RGB lighting from devices connected to the RGB 4-pin headers. The software utility works with Windows 7 or later and allows you to enter hex color code and numerical RGB color spaces. For instance, those wanting a true red color could enter Hex number 0000FF or RGB Color 255/0/0, which makes it easier to perfectly match the RGB color.

The P7-H1 hub connects to your motherboard via a USB 2.0 port and a 4-pin PWM fan connector. The latter allows your motherboard to control fan speed. Aerocool tells us that if you need to connect and sync additional RGB devices and fans, you can link up to eight individual hubs through a single motherboard.

The 120mm P7-F12 fans all support up to 16.8 million colors, and the illumination emanates from six RGB LEDs in the middle of the fan. Aerocool uses semi-translucent blades, and we found the lighting effects to be less harsh than RGB LEDs placed inside the fan frame, because the light source is hidden. The P7-F12 are slightly less bright than other RGB fans we've looked at, but that's not always a bad thing, especially in a system with lots of other RGB LEDs.

Aerocool designs the P7-F12 to operate at 1,200rpm, producing a maximum airflow of 45.8cfm. Power users who require high airflow probably won't love the comparatively slower rpm rate, but the fan speeds are ideal for quiet computing enthusiasts. The hydraulic bearing fans feature a low noise level of only 14.5dB(A). In our testing, fan noise level was pretty much inaudible when installed inside a case.

The P7-F12 Pro kit sells for $59.99, which is a good value considering that a P7-F12 fan costs $17.99 when sold by itself. You can also purchase the P7-H1 hub individually for $25. The hub would be ideal for anyone who wants a single point of control for Aerocool's RGB products, including upcoming cases and PSUs. It would also work with other lighting parts with a RGB 4-pin connector. ∎

BY NATHAN LAKE

Fan Specs: Dimensions: 120 x 120 x 25mm; Speed: 500-1,200rpm; Maximum airflow: 45.8cfm; Maximum air pressure: 1.01mmH20; Maximum noise: 14.5dB(A); Connectors: 3-pin, RBG header; LED: RGB 16.8 million colors; Current: 0.15A

Hub Specs: Outputs: 5 4-pin PWM fan connectors, 2 RGB headers; External connectors: 1 USB 2.0, 1 4-pin PWM, 1 2-pin Molex

CPU RANKING   0 = ABSOLUTELY WORTHLESS   2.5 = ABSOLUTELY AVERAGE   5 = ABSOLUTELY PERFECT

RIG
OF THE MONTH

XOTIC PC G4 Triton

HEAVY GEAR
4.0 OUT OF 5
CPU

XOTIC PC is a boutique builder that has regularly impressed us with its in-house painting and hydro-dipping services that transform the external look of a build. To our surprise, much of this G4 Triton's sophistication is inside the case, while the external aesthetics are comparatively straightforward. That's not to say there's no polish to the chassis, as the G4 Triton is built with Phanteks' Enthoo EVOLV MATX Tempered Glass Edition, featuring hinged suicide doors and smoked-glass side panels. Despite the mATX form factor, XOTIC PC manages fill the G4 Triton with a custom liquid-cooling loop and a full-sized NVIDIA GeForce GTX 1080 Ti.

Starting price for the G4 Triton is $1,049, so this $4,200 configuration

G4 Triton		
$4,167 as tested		
XOTIC PC		
www.xoticpc.com		

boasts plenty of upgrades. Let's start by taking a closer look at the cooling loop, which you can configure by selecting XOTIC PC's Custom Fabricated Frostbite Water Cooling (Stage 2) upgrade. Stage 2 adds $899 to the system cost and expands the cooling loop to the CPU (an Intel Core i7-7700K) and GPU (the previously mentioned GeForce GTX 1080 Ti). XOTIC PC uses straight runs of PETG hardline tubing and black Bitspower fittings for attractive bends. The coolant itself looks great, as well, with a blue pearlescent color that matches the blue LED lighting inside the case. The metallic flakes inside the coolant also complement the silver components.

There are many shades of blue inside this G4 Triton, but with all of the RGB LEDs in the rig you can easily alter the illumination to a complementary color.

The Enthoo EVOLV MATX TGE supports either a vertical or horizontal radiator up to 240mm long, and in our system, the builder installed Aqua Computer's 240mm Airplex Radical 2 into the front panel. XOTIC PC uses the free space in the top panel for an EK-XRES Revo D5 pump/reservoir combo. The reservoir's prominent placement in the top of the case is an excellent way to show off the pearlescent coolant. XOTIC PC also adds a temperature sensor below the reservoir input and an LCD readout that displays coolant temperature in real time.

Blue is the primary color with this G4 Triton build, but XOTIC PC designed the system to let you pick virtually any color theme; there are 10 available coolant and tubing colors. XOTIC PC also installs custom-braided cables it creates in-house, and as with the coolant and tubing, you can choose the color that works best with your scheme. The cabling in this build is a blend of black, white, and grey sleeving—a mix that looks good next to the GPU's black top cover and the motherboard's "ARCTIC" PCB.

The interior of our build is well-lit and includes multiple RGB components, all of which are set to a dark blue. Two 120mm Thermaltake Riing RGB fans illuminate the front panel, and there's another providing rear exhaust. XOTIC PC also installed a few Phanteks RGB LED light strips along the top and side panels to brighten up the internal hardware behind the smoked-glass side panel. Last but not least, our build features G.Skill's Trident Z RGB memory. The RGB LEDs make it easy to switch the system lighting down the road, if you want to try out a complementary color.

The hardware configuration inside is one of the more powerful setups for the G4 Triton. Intel's Core i7-7700K is plenty fast with a Turbo Boost speed up to 4.5GHz and a base clock of 4.2GHz. Going with the Custom
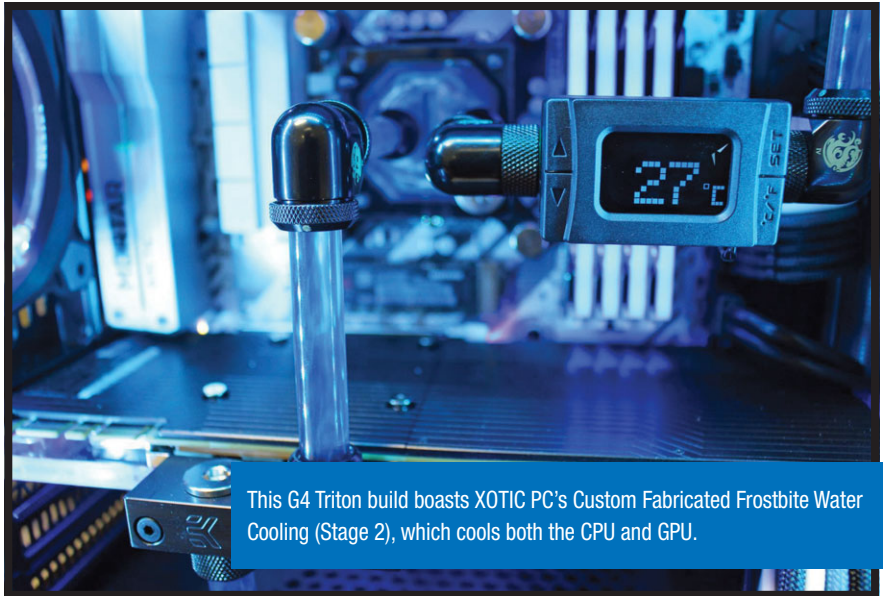
This G4 Triton build boasts XOTIC PC's Custom Fabricated Frostbite Water Cooling (Stage 2), which cools both the CPU and GPU.
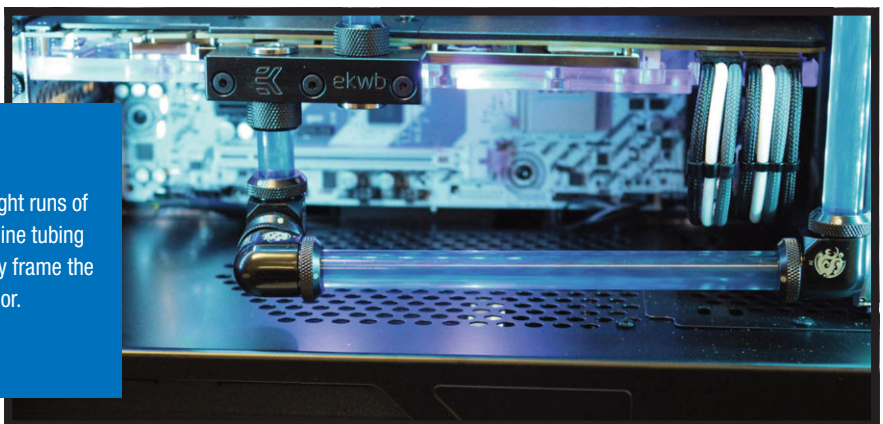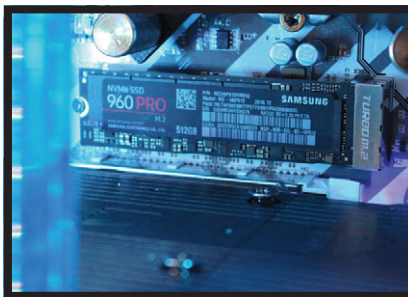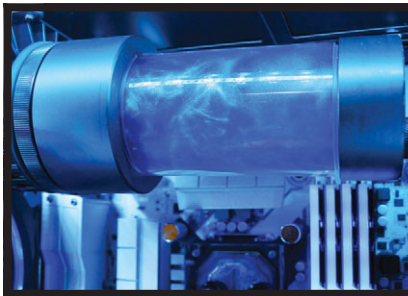
Straight runs of hardline tubing nicely frame the interior.

XOTIC PC offers a variety of color combinations with its free, custom-braided cables.

Fabricated Frostbite Water Cooling should also provide plenty of room for overclocking, but this configuration didn't call for it. As such, XOTIC PC was able to cut costs a bit by going with MSI's B250M MORTAR ARCTIC. If you were to add the overclocking service (multiple stages available, starts at $49), XOTIC PC recommends going with MSI's Z270M MORTAR or ASUS' ROG STRIX Z270G GAMING.

The 32GB G.Skill Trident Z RGB kit in this build can blaze at up to 3,866MHz, but again, you'll need a different motherboard to do so, as the B250M MORTAR ARCTIC only supports memory at speeds up to 2400MHz. Going with a Z270 chipset board would open up the motor on this G.Skill kit. Alternatively, those who don't want a speedy RGB kit could save $200 by going with a 32GB HyperX Fury DDR4-2666 kit.

One of the things we really like about the B250 chipset in comparison to the B150 chipset is that Intel adds four PCIe 3.0 lanes that support Rapid Storage Technology and PCIe SSDs. XOTIC PC takes full advantage of the PCIe storage lanes with a 512GB Samsung 960 Pro. In testing with CrystalDiskMark, the Samsung drive posted a Sequential Read (Q32T1) of 3282MBps, while 4K (Q32T1) random reads were 746MBps. For personal file storage, our build also includes two 2TB Seagate FireCuda drives. Our drives weren't configured in RAID, but should you want to RAID them, there's no extra cost for XOTIC PC to set up a RAID 0, 1, or 5 configuration.

The G4 Triton's other benchmark numbers are what you'd expect from this collection of high-end components. Want to game at 4K? The liquid-cooled NVIDIA GeForce GTX 1080 Ti produced more than 60fps in all of our game tests, highlighted by 73fps in Metro: Last Light. When testing games at 2,560 x 1,440, frame rates for all tests were above 100fps. Intel's Core i7-7700K keeps up its end of the bargain with 2073.28 pixels per second in POV-Ray 3.7. In 3DMark's Physics test (part of the Fire Strike Extreme benchmark), the Core i7-7700K helped to deliver a score of 14003.

We give XOTIC PC high marks for the G4 Triton's look, and in particular, we like how easy it would be for a customer to completely tailor the color scheme. The cooling loop is a thing of beauty, too. Personally, we'd have gone with a Z270 motherboard and that's certainly an option, as XOTIC PC offers a couple of good Z270 boards in the custom configurator. XOTIC PC is currently offering a free upgrade to a three-year warranty (with lifetime labor and lifetime tech support) and says this offer should be good through 2017. ∎

BY NATHAN LAKE

Benchmark Results	G4 Triton
3DMark Fire Strike Extreme	
Overall Score	12661
Graphics Score	14074
Physics Score	14003
PCMark 8	
Creative Score	6076
SiSoftware Sandra 2017	
Dhrystone AVX2 (GIPS)	203.36
Whetstone AVX (GFLOPS)	119.74
Multi-media Integer AVX2 x32 (Mpixels/s)	572
Multi-media Long-int AVX2 x16 (Mpixels/s)	209.41
Multi-media Quad-ALU x1 (Mpixels/s)	2.35
Floating B/F AVX/128 (GBps, mem bandwidth)	28
CrystalDiskMark 5.1.2 (MBps)	
Sequential Read (Q32T1)	3282
Sequential Write (Q32T1)	1989
Random 4K Read (Q32T1)	746.1
Random 4K Write (Q32T1)	622.3
POV-Ray 3.7 (Pixels/s)	2073.27
Cinebench 15 (Points)	955
Games	2,560 x 1,440
Metro: Last Light (Very High, 16xAF; SSAA off)	124fps
Dying Light (High, AO On, AA On, Vsync Off)	148fps
Witcher 3: Wild Hunt (Vsync Off, Unl. FPS, Ultra)	108fps
Games	3,840 x 2,160
Metro: Last Light (Very High, 16xAF; SSAA off)	73fps
Dying Light (High, AO On, AA On, Vsync Off)	79fps
Witcher 3: Wild Hunt (Vsync Off, Unl. FPS, Ultra)	62fps

Specs:

Processor: Intel Core i7-7700K @ 4.5GHz; Motherboard: MSI B250M MORTAR ARCTIC; GPU: NVIDIA GeForce GTX 1080 Ti; RAM: 32GB G.SKILL Trident Z DDR4-3866MHz (operating at 2400MHz); Storage: 512GB Samsung 960 PRO (OS drive), 2TB Seagate FireCuda (x2, no RAID); PSU: EVGA SuperNOVA 850 G2; OS: Windows 10 Home 64-bit; Warranty: 3 years

State-Of-The-Art Standards

XMP

Generally speaking, modern BIOS designs make it easy to load XMP configurations.

Before Intel introduced XMP (Extreme Memory Profile) in late 2007, overclocking memory was often a time-consuming, guess-and-check exercise. "After making changes to multiple memory settings in the BIOS, enthusiasts would reboot the system and hope it booted OK," says Les Henry, Patriot vice president of engineering. "If there were any issues, they would need to go back and change some of the settings, by trial and error, to get their system to boot at the proper speed." XMP shortened the process to an exceedingly easy single step—enable XMP in the BIOS.

10 years later, XMP is still the fastest way to overclock system memory, and on the consumer end, the process of using XMP hasn't really changed much over the years. But have you ever wondered how memory and motherboard makers certify kits and ensure system compatibility among multiple chipsets? We talked with experts at a few prominent memory and motherboard companies to discover what goes into the XMP specification.

The Ins & Outs Of XMP

XMP specifications are programmed in the SPD (serial presence detect),

XMP shortened the process to an exceedingly easy single step—enable XMP in the BIOS.

Patriot's Viper memory kits, such as this 3,200MHz kit, often feature aggressive timings and speeds.

If you're interested in the different timing tables for a module or kit, CPUID's CPU-Z utility is an excellent way to get that information.

which is a section inside the DIMM's EEPROM (electrically erasable programmable read-only memory) with memory device parameters and configuration details. In short, SPD information describes exactly how the system should operate the installed memory. In addition to the XMP values, the SPD contains other bits of information about the module, such as what type of memory is installed and standard JEDEC parameters.

You've likely noticed the JEDEC parameters, which are slower base settings with relaxed latencies, on your first visit to the BIOS after building a system. Typically, motherboards default to the base JEDEC configuration because the fail-safe settings should ensure the system will boot right away. For example, Patriot's 16GB Viper 4 DDR4-3400MHz kit features a JEDEC speed of 2133MHz at a latency of 15-15-15-36. The Viper 4 onboard XMP profile, by comparison, tells the motherboard to operate the memory at 3,400MHz at timings of 16-18-18-36, and bumps the voltage from 1.2V to 1.35V.

Once you've selected the XMP profile in the BIOS, the system will utilize XMP's faster speeds and optimized latencies. On some modules, you might be able to choose one of two XMP settings. When Intel first created the two-profile design, the first profile was designed to be an enthusiast speed that was certified under Intel's Extreme Memory Certification program, while the second profile is the memory's fastest possible setting, and it might not work on every system.

In recent years, memory manufacturers have started using the second profile as a slower option that's an intermediate speed between the default JEDEC and fastest settings. If you're interested in finding the different timing tables for a module or kit, CPUID's CPU-Z utility is an excellent way to get that information. Just click the SPD tab in the CPU-Z app and

you'll be able to see the various profiles loaded into the module, as well as the DRAM frequency (you'll need to double the frequency, as DDR memory carries two bits of information per cycle) and timings for each profile.

The Verification Process

"When qualifying new speeds and timings, our engineering team will test these modules across multiple platforms to test for compatibility," says Henry. "For our high-end OC DDR4 modules, we will test them on X99, Z170, Z270, and AMD X370 platforms." Once internal testing is finished, Patriot sends sample kits to board vendors, so they can test the kits at the suggested XMP settings.

Motherboard makers also play a big part in XMP development. "During the verification process, we tune the XMP, and exchange our experience to make the XMP work well," says Toppc Lin, QVL memory manager at MSI. Consider for a moment the sheer number of motherboards and memory kits on the market. The XMP qualifying process in no simple undertaking. "We work with many memory module makers, such as Kingston, G.Skill, Corsair, ADATA, and many others, to verify the XMP," says Lin.

Impressively, MSI has already managed to qualify a huge number of memory modules for Intel's new X299 platform. For example, as of press time the X299 GAMING

Even before the X299 GAMING PRO CARBON AC was officially released, MSI had validated over 200 memory kits and modules for use on the board.
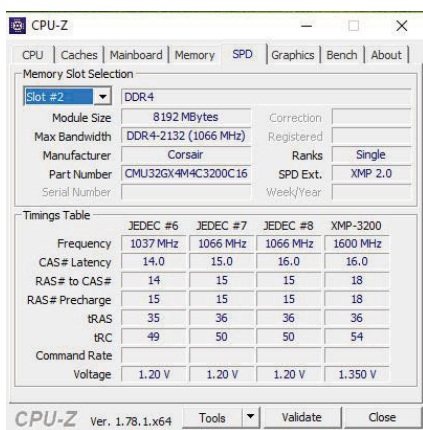
CPU-Z's SPD tab shows the JEDEC and XMP settings built into a memory module.
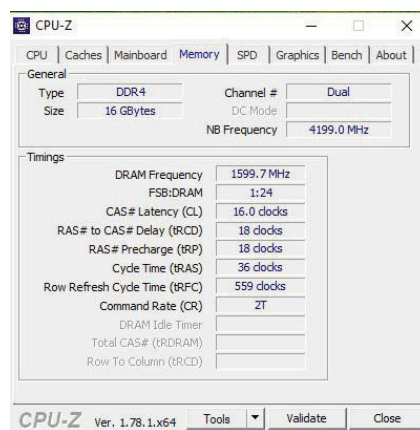
In the Memory tab, CPU-Z will list the current frequency and timing specifications.

Some memory modules feature two XMP profiles with one rated at the highest speed and another at more relaxed timings or a slightly slower speed.
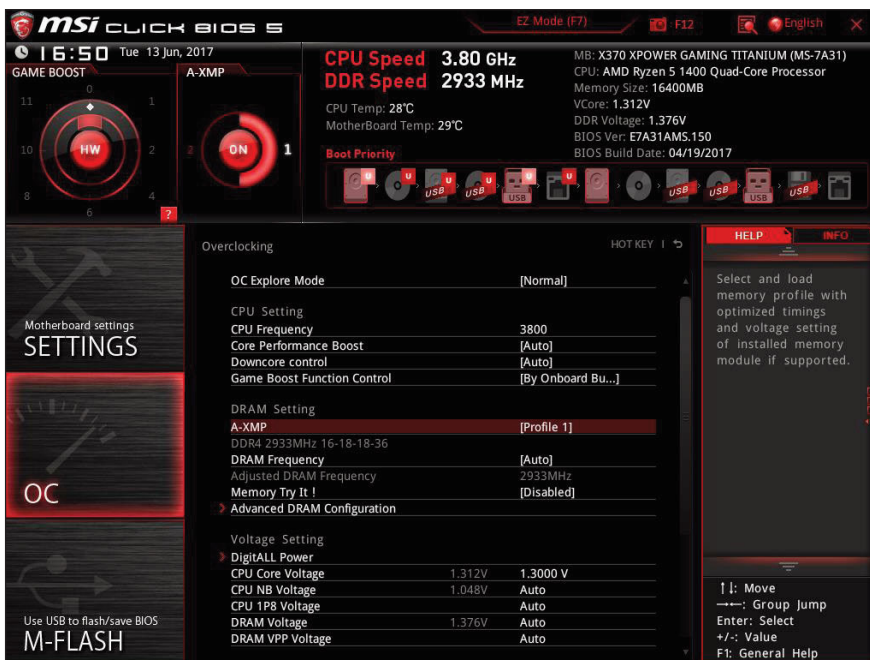
As seen in the MSI BIOS, motherboard manufacturers also work to support XMP settings over AMD platforms.

As with processors, the overclocking capability of a single module is not always consistent, which is why MSI focuses on testing with weak DIMM modules. "No matter how weak a memory kit is, we want to ensure it works on our motherboards." Motherboard manufacturers maintain detailed qualified memory module lists, so you can be sure a specific kit will work with a particular mainboard.

The XMP validation process works similarly for GIGABYTE. "We test the sticks in our lab, and they test it in their lab," says Matthew Hurwitz, GIGABYTE technical marketing manager. "If any issues are discovered, both teams work together to fix the issue and retest." GIGABYTE has cross-validation programs with a large number of memory manufacturers. "This cross-validation is extremely time-consuming for both parties, but something GIGABYTE is deeply committed to," says Hurwitz.

Despite the lengthy compatibility charts, motherboard companies can't verify every single module or kit on the market. In most cases, we've found kits not on the qualified vendor chart will work, but it's not a guarantee. Intel, for its part, also keeps a running list of modules verified for XMP; you can find it at http://bit.ly/memchart.

What About AMD Platforms?

"Tuning memory on AMD and Intel platforms is very different," says Lin. "Most XMP settings are tuned and verified on Intel platforms and it will not apply on AMD platforms." That doesn't mean that motherboard makers, including MSI, refuse to support XMP on AMD platforms. It just takes a little more work.

"All motherboard vendors support XMP profile transfer into AMP profiles so far, but under different names," says Henry. "ASUS calls it D.O.C.P [Direct Over Clock Profile] and MSI names it A-XMP." Lin tells us, "We base the presets on the character of memory IC and tune it for AMD, trying to make XMP settings work on AMD, too." In some cases, the XMP settings might be slower than a

PRO CARBON AC boasted more than 200 qualified kits. The fastest kit, a 4GB Avexir kit, operates at up to 3,800MHz, and MSI says the board can support DDR4 up to 4,266MHz. "We test all DIMM slot combinations to make sure each kit works well on our motherboards," says Lin. "We also test the weak DIMM with a CPU that has a weak IMC [integrated memory controller] to ensure compatibility."

kit's rated speed, and this is based on the testing the motherboard maker has done with the kit. In a few cases, XMP settings might not work at all.

"Ryzen doesn't actually load XMP profiles directly," says Hurwitz. "When you set an XMP profile on an AMD chipset, your board will read the XMP profile of the memory and apply the settings manually." The lack of native support can create problems without proper testing from the motherboard manufacturer. "There are subtle nuances (timings) that don't translate exactly requiring a fair amount of testing and tweaking behind the scenes," says Hurwitz. "Currently Ryzen processors seem to be able to hit 3200MHz consistently and 3600MHz with the right combination of hardware."

Some of Ryzen's XMP speed issues can, partly, be put down to AM4 platform maturity. Henry notes "We expect results to improve with BIOS updates in the near future." Enthusiasts' interest in the AM4 platform should help to drive development and push speeds higher and higher. As such, the unstable results with some memory ICs should be resolved once the new architecture is better understood by all parties.

XMP Version Numbers

Software utilities and DIMM specifications will often list the Intel XMP version, such as 1.2, 1.3, or 2.0. "There is no performance difference between XMP 1.3 and 2.0, nor does it indicate platform change," says Lin. "Because DDR4's SPD file size is bigger [512KB] than previous DDR [256KB], XMP has to re-define the address of SPD and this is XMP 2.0." Another change with XMP 2.0 is that the SPD contains information about the module PCB, while version 1.3 only includes speed, timing, and voltage parameters. Generally speaking, DDR3 modules support XMP 1.3, while DDR4 modules are built with XMP 2.0.

Is There Any Headroom For Tweakers?

"For our higher-end speeds, we are aggressive on the preset profiles, and there is not much room for overhead," says Henry. "With the lower-speed modules, there might be some more overhead to push the modules." In general, Patriot recommends that you stick with the XMP speed. Motherboard makers, on the other hand, find there's slight room for performance boosts. "Every kit of memory does not have its own unique timings or speed," says Hurwitz. "You may be able to slightly lower your timings or increase the speed."

It's possible, for example, that a memory vendor received a huge order of 3,200MHz ICs and didn't have the chance to test it at 3,600MHz. "I encourage users to see how far they can push their memory," says Hurwitz. "Worst-case scenario, you have to clear your CMOS and go back to XMP." A few motherboard makers also offer modes that can improve upon the XMP settings. "We provide several 'Memory Try It' profiles for tighter timings and better performance than stock XMP, based on the same DIMM voltage as XMP," says Lin, who notes that these profiles are safe for 24-hour use.

Quick, Easy, & Extreme

Some enthusiasts may still prefer manually tweaking DRAM settings to overclock memory, but it doesn't get much easier than XMP if you want to quickly optimize memory timings, speed, and voltage. After talking with some memory and motherboard manufacturers, we learned that it takes a lot of cooperation between vendors to make XMP work as seamlessly as it does. Fortunately, both motherboard and memory makers appear dedicated to XMP, and it speaks volumes about how valuable XMP has become when manufacturers are manually setting up XMP functionality for AMD platforms. ∎

XMP's Original Competition

Remember when NVIDIA designed its own chipsets? Back in 2006, NVIDIA introduced an SLI-ready memory that would work with nForce-based motherboards via EPP (Enhanced Performance Profile) settings. NVIDIA worked with memory manufacturers to optimize module performance and it certified the kits as SLI-ready. Way back, we tested out an SLI-Ready 2GB OCZ DDR3 kit that operated at 2,000MHz and timings of 9-9-9-30. It retailed for $249.

Panel Discussion
Modern Monitors, Examined & Explained

The "Look Better" industry is a multibillion-dollar business. Take your pick between new-fangled diet pills, Navy SEAL-inspired extreme (add Xes and capitalize as necessary) workouts, and/or various physique-shaping garments; if you're not satisfied with your appearance there are plenty of people eager to share the hidden secrets they've unlocked and wondrous products they've concocted all for a reasonable fee. You can trust them, too, because every one of these hucksters has spent a weekend communing with real spirit healers.

Thankfully for power users, the path to better-looking PC graphics is considerably less sketchy and a lot more certain. A more powerful graphics card delivers increased frame rates for smoother gameplay and generally lets you enable an assortment of visual effects to further ensorcell the eyes. On top of that, buyers have access to hardware reviews and benchmark data that give them a general idea of just how much better a new graphics card will make their games look.

Upgrading to a mightier graphics card helps, but if you truly want to overhaul your PC's picture presentation, it's only part of the equation. The other part is that big rectangle sitting in front of your keyboard. Short of failings such as checkerboard of dead pixels or color reproduction so poor that even a dog could recognize it, most of us are content to let our monitors chug along for many years without considering an upgrade. Maybe it's time to start. A new monitor won't make games run any faster,

but there's little doubt it will make them look better. A new monitor should make everything else you view on your PC look better, too. As manufacturers continue to develop and introduce new technologies, just because the widescreen LCD you bought in 2006 isn't broke doesn't mean you shouldn't fix it.

Because monitors have a decent shelf life, we won't shame anyone who's not up to speed on LCD developments over the last year or two, or more. But if you haven't been following along, you don't know what you've been missing.

Back To Basics

Despite a number of innovations that have improved monitors' picture quality, a lot of the fundamentals are the same as ever. Attributes such as contrast ratio, brightness, and refresh rate still matter, and they're still useful for distinguishing one display from another. This is your refresher course.

Why stop at 4K when Dell's UP3218K takes you all the way up to 8K? (That's 33,177,600 pixels if you're keeping score at home.) It's yours for the low, low price of $4,999.99.

Resolution. For most buyers, this is the first specification to check before drilling down into a monitor's other details. In simplest terms, a monitor's resolution is the number of pixels it contains. Resolution is presented as "*horizontal pixels* x *vertical pixels*," so a 1,920 x 1,080 monitor has 1,920 horizontal pixels and 1,080 vertical pixels.

Don't assume a physically bigger panel—in other words, its screen size, measured diagonally—results in a bigger image. For example, a 24-inch 1,920 x 1,200 monitor would display a large scene in a videogame than a 25-inch 1,920 x 1,080 monitor. The difference is even more glaring when you see a 4K monitor side by side with a 1080p monitor of the same screen size.

Speaking of 4K, we'll assume you have a passing familiarity with the feature manufacturers fall over themselves marketing to consumers. Strictly speaking, a true 4K panel has a resolution of 4,096 x 2,160, although 3,840 x 2,160 UHD screens colloquially receive the same billing. The latter are also far more widespread because of their preferred 16:9 aspect ratio.

Despite recently claiming the throne, 4K monitors may not enjoy a long reign. Earlier this year, Dell debuted the UP3218K, a 31-inch 8K monitor with a whopping 7,680 x 4,320 resolution and a $4,999.99 price tag to match. Now, before deciding which of your organs to auction on the black market, remember that even the most powerful graphics cards are just now able to average 60fps at 4K resolutions in demanding games.

Brightness. Or, if one your hobbies includes pedantry, feel free to use "luminance" instead. Either way, a monitor's brightness refers to the amount of light emitted from a specific area; in this case, it essentially measures (in cd/m², or candela per square meter) the brightness of a monitor's backlight.

Depending on your environment, brighter isn't always better. In well-lit office environments, for example, you can benefit from using a monitor with a higher cd/m² rating. Be aware of the hazards associated with staring too long at a bright LCD. When retreating to your pitch black gaming lair, an extremely bright display isn't as important, with the following exception.

Recently, brightness is back in the spotlight. HDR (high dynamic range) has already taken over the conversation regarding TVs, and it's set to become the next big battleground for monitor manufacturers, too. We'll discuss HDR separately in this article, but a monitor must have an extremely high brightness rating in order to handle the demands of HDR video.

Contrast ratio. Play any afraid-of-the-dark horror game and you'll understand the importance of a monitor's contrast ratio. In simplest terms, it measures the ratio of luminance between a monitor's brightest color, white, and its darkest, black. However, because there isn't a defined standard for measuring contrast ratio, it's one of the most misreported/exaggerated specs of any component. When you see a manufacturer report an eye-popping contrast ratio of 10,000,000:1, dial up your skepticism to its max setting. In this instance, that manufacturer is citing the monitor's dynamic contrast ratio, which measures the brightest white and darkest black over time, rather than at a specific moment. Calculating the contrast ratio based on a single instant in time determines static contrast ratio, and that's the measure you should use when evaluating displays.

Most monitors aimed at enthusiasts will have a static contrast ratio of

Gamers tend to prefer TN (twisted nematic) panels for their ultra-low response times, such as BenQ's ZOWIE XL2411, which has a dynamite 1ms response time. But IPS (in-plane switching) panels have closed the gap considerably over the last few years.

1,000:1, so this is where we recommend starting your search. Above all, remember to take impossibly large dynamic contrast ratios with an asteroid of salt, as this metric's worth has been debunked on a seemingly annual basis. Don't let yourself be fooled.

Response time. Continuing the trend of somewhat useful, somewhat not monitor specifications, the evolution of response time as it's now commonly reported reflects a tendency to publish the best-looking but not necessarily most useful numbers. If you open your trusty "*Computer Power User* Dictionary, 3rd Edition," the definition for response time is the measure of time in milliseconds a monitor's pixels need to change from one state to another. In theory, a monitor's response time is connected to motion blur. If a monitor's response time is too high, its pixels can't keep up with a rapidly changing onscreen image, resulting in "blurry" artifacts.

Years ago, poor response times plagued LCD monitors in particular, but today the problem has been all but eradicated.

Although virtually every manufacturer advertises a much softer, and more nebulous, gray-to-gray (GTG) response time (a pixel changing from one shade of gray to another and back, as opposed to a pixel changing from black to white and back), the fact is that high-end monitors' response times are good enough that motion blur is no longer an issue. We wouldn't expect most people to perceive a difference between a 1ms GTG display and a 2ms GTG display, for example. Hardcore gamers typically favor monitors with TN (twisted nematic) panel capable of these low response times and say that IPS (in-plane switching) panels with higher response times aren't ideal for fast-paced games. We're not convinced anyone who doesn't play Counter-Strike professionally will notice a difference, but there certainly are differences between TN and IPS displays that are worth mentioning.

Don't Get It Twisted (Or, Maybe, Do)

As consumer LCDs have evolved, three types of panels have become the

leading contenders for your enthusiast dollars. We've already mentioned TN and IPS; the third is VA (vertical alignment). Understanding the differences between this trio can help you make a better buying decision. We'll be painting in broad strokes because each panel technology could fill an article in its own right.

The twisted nematic effect is the reason LCDs became a viable option. The very basic principle is that each pixel contains liquid crystals sandwiched between glass substrates and polarizers. The crystals are "twisted," arranged in a helical shape, to allow light from the monitor's backlight to pass through. When voltage is applied via electrode, the crystals "untwist," blocking the backlight.

Unsurprisingly, IPS panels arrange and manipulate their liquid crystals differently than their TN counterparts. In an IPS panel, the crystals are always arranged parallel, or in the same plane, as the substrate and polarizers. Applied voltage makes the crystals rotate 90 degrees on the axis that remains parallel to the substrate and polarizers, so they're always in the same plane.

Finally, we come to VA panels, which, to a certain extent, occupy a middle ground between TN and IPS panels. With a VA panel, the liquid crystals are arranged (as in, aligned) vertically, perpendicular to the substrate's and polarizer's plane. Applied current rotates the crystals horizontally.

In practice, panels based on these technologies each present general advantages and disadvantages that buyers should know. TN panels boast the best response time of the bunch; it's not uncommon for these LCDs to boast GTG response times of 1ms or 2ms, which is why gamers zipping across the battlefield and frenetically swiveling their cameras tend to prefer them. As the oldest and most developed of the three types of panels, TN monitors tend to be the least expensive of the bunch, but you'll pay in other ways. The most glaring hole in a TN panel is its color reproduction. Viewing a TN

LCD at an off-center angle exposes a progressively poor image, and TN panels are generally not favored for any type of work that relies on pristine image quality.

Color reproduction and image quality are precisely what makes an IPS monitor appealing, especially to users who need a display for image editing, graphic design, and so forth. (And yes, videogames that present stunning visuals—think Witcher III and Grand Theft Auto V—should in theory look more vibrant on an IPS display.) Hardcore gamers might turn up their noses at an IPS monitor's inferior response time, but modern IPS displays have improved dramatically. You can easily find IPS monitors with GTG response times as low as 4ms, to most eyes likely indistinguishable from a high-end TN panel. Otherwise, IPS monitors are typically more expensive than their TN counterparts.

Returning to the muddy middle, we find VA monitors. Colors will be better on a VA display than a TN display, and it's generally accepted that VA monitors produce the best blacks of the three display types. But the benefits end there. VA panels struggle with relatively poor response times; most gamers turn to TN or IPS monitors first.

Lurve For Curved

Every couple of years, TV and monitor manufacturers are eager to hype "the next big thing" in an effort to convince you that your screen is terrible and that your life will only have meaning again if you upgrade to the latest model. Sometimes, the hype is legitimate. Other times, the hype is just hype.

One of the more recently hyped advances is curved displays. Whereas the CRTs of yore had convex screens and flat-panel monitors are, well, flat, a curved monitor has a concave screen. As the technology has developed, curved displays are no longer limited massive, expensive models, either. You can find them in a wide range of sizes and prices.

As long as you're not intending to share your monitor, so to speak, the primary

drawback of a curved display, nasty off-center viewing angles, doesn't really apply. Curved displays work best when you're viewing front and center, which is exactly how we use our monitors.

Curved displays are appealing for a number of reasons. Based on the shape of our eyes, a curved display presents a more uniform viewing distance and better viewing angles (again, only if you're parked right in the middle) than a flat panel of the same size. Curved display partisans will also swear that these screens deliver a more immersive experience, creating the sensation of being surrounded by the image. The real question isn't whether these advantages exist but rather how truly beneficial they are to the viewer.

The answer is, for the most part, "it depends." We have no way of quantifying immersion, obviously, and because the sensation is so subjective, someone sitting in front of a curved display might not feel any more immersed than if they had been using a flat panel or multimonitor setup. Further, popular opinion suggests that the visual effect of a curved display is more noticeable on a larger screen. The difference between a 24-inch curved LCD and 24-inch flat LCD could be negligible. With this technology, our best recommendation is to trust your eyes.

A Refreshing Change

The hype train's next stop is refresh rate. Not to be confused with response time, refresh rate indicates, in Hz, how frequently a monitor is capable of refreshing its image. For years, the refresh rate for monitors topped out at 60Hz. In order to take advantage of a monitor's maximum refresh rate, you'd need a graphics card capable of pumping out 60 frames per second.

For high-end graphics cards, soaring beyond 60fps isn't a problem. Instead, it creates problems. For example, when a graphics card renders in-game 3D images higher than a monitor's refresh rate, a phenomenon called screen tearing occurs. Essentially, the monitor can't "keep up"

with the graphics card, which results in the monitor drawing incomplete images that look torn. No one spends a few hundred dollars (or more) on a monitor and several hundred dollars (or more) on a cutting-edge graphics card and hopes to experience screen tearing.

Traditionally, we've turned to Vsync to battle screen tearing. In a nutshell, Vsync works by capping a graphics card's output to a monitor. Excess frames are dealt with using techniques such as double buffering and page flipping. However, Vsync itself can cause problems of its own, such as stutter, which occurs when the graphics card's frame rate dips below 60fps.

As they so often do, the two juggernauts in PC graphics, AMD and NVIDIA, have offered their services to fix the problem. The only catch is that, as is so often the case, you have to pick a side. To combat the issue of screen tearing, stutter, etc., both companies have developed technologies that can broadly be described as adaptive

sync. Although both companies' implementation differs on particulars, the underlying idea is the same: With a compatible graphics card and monitor working in tandem, adaptive sync matches the monitor's refresh rate to the graphics card frame rate. The big selling point is that a compatible monitor's refresh rate can zoom past 60Hz and keep on trucking, all the way up to 144Hz (and potentially higher). In theory, adaptive sync gives high-end graphics cards the ability to stretch their legs and run, knowing the monitor can match them stride for stride, resulting in gameplay as smooth as a politician's stump speech. AMD's version of adaptive sync is FreeSync. Sticking to its brand, NVIDIA call its take on the tech G-SYNC. Both of these are now in their second generation, and you can read more about them in our February 2017 issue "State-Of-The-Art Standards."

Aside from being able to achieve refresh rates higher than 60Hz, the

key takeaway for adaptive sync is that you have to hitch your wagon to one of these horses. That means that if you have a GeForce graphics card capable of G-SYNC, you can't connect it to a FreeSync monitor and take advantage of adaptive sync. So, if you're not prepared to upgrade your graphics card, you'll be chained to whichever version of adaptive sync is tied to your GPU.

On the other hand, anyone building a new system from the ground up or buying a new graphics card and monitor has a decision to make. At the time of this writing, we recommend postponing such a decision if you can afford to wait. Monitors compatible with NVIDIA's or AMD's next generation of adaptive-sync technologies, G-SYNC HDR and FreeSync 2, respectively, are only now trickling into the market. FreeSync 2 in particular rectifies one of FreeSync's most glaring issues, poorly handling situations when a graphics card's frame rate dipped below the bottom threshold of a FreeSync monitor's variable refresh rate range. If FreeSync 2 monitors have indeed closed the performance gap with G-SYNC, the lower cost of a comparable FreeSync 2 monitor (FreeSync monitors don't require specialized, built-in circuitry like G-SYNC monitors, making them less expensive), makes AMD's take on adaptive sync a lot more appealing. We expect FreeSync 2 and G-SYNC HDR monitors to be out in force by the end of this year.

HDR: Not Just For Photographers Anymore

If you're curious about whether a new technology is the real

Capcom's utterly terrifying Resident Evil 7 took the franchise back to its horror roots, but it's also one of the first PC games to support HDR (high dynamic range) visuals. The requirements for HDR gaming are steep, including a monitor rated for high brightness, contrast, and color gamut; your best bet is a display that's certified for FreeSync 2 or G-SYNC HDR, AMD's and NVIDIA's respective adaptive-sync technologies that also support HDR, and of course, a compatible graphics card.

ASUS' ROG Swift PG27UQ, available later this summer, is equipped for G-SYNC HDR.

deal or a real dud, here's our general advice: Picture quality is king. Throw your 3D glasses in the trash and pay attention to improvements and innovations that give you the best picture. What started with 1080p has become 4K, and before long we'll be basking in HDR.

HDR isn't a new concept, but it's still at the frontier of PC monitors for a few reasons. First, HDR video requires considerably more brightness, deeper blacks and more brilliant whites, and a wider color gamut (essentially, the range of distinct colors a monitor is capable of producing) than most monitors are capable of producing. You'll get an image with colors and contrast you've never before experienced on a PC monitor, but you'll pay a pretty penny in the process.

Although HDR gives you incredible image quality, it does present a drawback that's particularly serious for gamers. As also discussed in the February 2017 "State-Of-The-Art Standards" article, all of the heavy lifting (HDR metadata, tone mapping) puts a strain on the monitor that results in deal-breaking input lag— over 100ms on some HDR TVs, which is a nonstarter for gaming.

Thankfully, FreeSync 2 and G-SYNC HDR tackle the input lag problem along with improving adaptive sync. For example, FreeSync 2 relieves the monitor of HDR tone mapping duties, shuttling that work to the GPU instead. NVIDIA is short on particulars regarding how G-SYNC HDR deals with input lag but promises "near-zero input latency" from compatible monitors.

Your best bet for an HDR PC monitor is to stick to AMD's or NVIDIA's ecosystem. Both companies have teamed up with monitor manufacturers and are certifying displays capable of FreeSync 2 or G-SYNC HDR, respectively. Remember also that gaming in HDR takes three to tango: Your GPU, monitor, and the game itself must support the technology.

HDCP & You

As screen resolutions continue to climb, picture quality becomes even more photorealistic, and graphics cards gain enough power to feed big, beautiful images to these screens, another constant that has remained is movie and TV studios fiercely protecting their IP. One

of the tools content producers use to do this is HDCP (high-bandwidth digital content protection). HDCP provides a secure connection between a 4K UHD Blu-ray player, which sends an encrypted signal to a compatible display, which decrypts it.

The latest version of HDCP is 2.2, and as we just hinted, its headlining change is support for 4K UHD. For as much as enthusiasts tout the power of their PCs, watching 4K UHD content is arguably easier for couch potatoes. A 4K TV and some type of playback device (whether that's a 4K UHD Blu-ray player, a compatible set-top box, or the TV itself) is all you need. For power users, in addition to the monitor, an HDCP 2.2-compatible source is also necessary. Keep this in mind if your system is a few years old.

In some situations, streaming 4K content on your PC is even more complicated. Until recently, the only way to watch Netflix in 4K on your PC was with the combination of Microsoft's Edge browser (sorry, Windows 7 stalwarts) and an Intel Kaby Lake processor; NVIDIA recently added driver support for Netflix 4K with its Pascal GPUs. We're treading on DRM's terrain (which is not strictly the same thing as HDCP) with this scenario in order to emphasize our point that merely having a 4K monitor with HDCP 2.2 probably isn't enough to unlock that glorious 4K content on your PC.

All Rise For Your Eyes

When you enter the monitor market, there will be a lot of standards, specs, and technologies to keep straight. We trust that you'll do your homework, and we also trust you to trust your eyes, because they're the best judge. Limited space at brick-and-mortar retailers makes it tough to check out a lot of displays in person, but it could give you the opportunity to see if things like 4K and/or HDR are worth the extra cost for you.

If you have a chance to walk the floor at a nearby LAN party, don't pass up the opportunity. It might be the biggest and best showroom available to potential buyers. ■

# Computex 2017
High Tech In The Far East

Of all the events we attend, few offer a deeper glimpse into what the future holds for PC enthusiasts than Computex. This year was no exception, as the biggest names in the industry practically paved the streets of Taipei, Taiwan with tempered glass and lit the northern tip of the sweltering island nation with digital, individually-addressable RGB LEDs. Here's a small taste of all the great things we saw at this year's big show.

GIGABYTE once again had a large portion of a whole floor of the Taipei 101 building all to itself, and it managed to fill all of that space with compact PCs, motherboards, modded systems, graphics cards, laptops, and LED lighting tech. One particularly neat demo was the BRIX Gaming VR system, which is a YETI mug-sized computer equipped with a 7th gen Kaby Lake Core i7-7700HQ processor and a GeForce GTX 1060, which is enough to run an immersive and engaging Oculus Rift or HTC Vive VR experience.

AMD and NVIDIA held press conferences at Computex, and although neither company talked much about new GPUs, they did take turns touting new products that we can't wait to get our hands on.
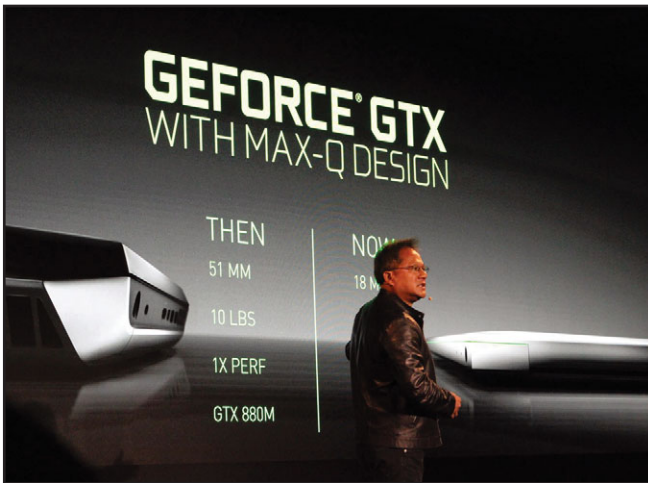
NVIDIA's MAX-Q technology is a software- and driver-tuning initiative designed to deliver maximum efficiency for laptops running GTX 1080, 1070, and 1060-based graphics. They do this by raising clocks and voltages in 5-watt increments until the performance gain that results is no longer worth the power draw. This way they get 90% of the desktop models' performance, but consume dramatically less power, resulting in laptop designs that are impressively thin and light.

AMD's press conference doled out more details about the hotly anticipated 16-core Threadripper processor, EPYC (formerly Naples) server processors, incoming Ryzen 3 processors, and future Ryzen Mobile APUs that will have integrated Vega graphics cores. The Frontier Edition Vega card, for professional graphics applications, will have launched as we went to press, but the gamer-centric flavor of Vega will be unveiled at SIGGRAPH at the end of July.

We saw a ton of cool tech at Corsair's suite, including a Bulldog HTPC mod with a hotrod makeover courtesy of Lee Harrington, new RGB fans, updated closed-loop CPU coolers, and shiny illuminated DRAM modules. One of our favorite sights, however, was the carbon fiber-wrapped Graphite 780T mod, complete with RGB everything and sleek bent tempered glass on the sides and front panel. Don't expect to find this one-of-a-kind stunner on Amazon or Newegg.

Patriot was another peripheral and memory vendor with a number of innovative products to show off. Here we have a couple DRAM kit concept designs with two variants of heat spreaders and LED bars. We preferred the right kit due to its fully exposed light bar, and although we loved the shiny metallic Viper logo on the left kit, nobody will see it when the kit is installed. We're looking forward to seeing Patriot's final design in the coming months.

ENERMAX's booth in the Nangang Hall had a dizzying array of products on display for attendees to peruse. We saw some iterative improvements in the company's new Platimax and MaxTytan power supplies, loads of RGB components and fans, and a new LIQTECH II closed-loop cooler with dual pumps and anodized red aluminum strips on the sides of the radiator. They were also demoing how the NEOChanger pump and reservoir combo had a maximum hydraulic head pressure of 5.2 meters at 4,000rpm, which lets you run longer cooling loops without needing a second pump.

MSI always makes a big splash at Computex, and this year was no different. The company showed off a little bit of everything it makes, from laptops and VR gear to motherboards and graphics cards. This demo prominently displays the MSI X299 GAMING PRO CARBON AC motherboard, the MSI CORE FROZR L CPU cooler, and the new behemoth triple-slot MSI GeForce GTX 1080 Ti Lightning Z with no less than three 8-pin PCIe power ports.

Our friends at Aerocool showed us a number of surprising things, including the firm's Project 7 gaming furniture including beanbag chairs, sofas, and racing-style chairs with LED-lit piping. We also got some hands-on time with a new RGB LED controller, cases, closed-loop liquid coolers, and some exciting new peripherals.

We met with Alphacool's Eddy Peters, and although the German liquid-cooling experts had a smaller booth, they managed to fill it with a number of impressive looking mods, an all-in-one hardline bending kit, radiators, reservoirs, pumps, fittings, and CPU and GPU waterblocks. Basically, Alphacool offers everything you need to keep your system running cool and looking amazing. While at the show, we also heard rave reviews for Alphacool from the company's many OEM partners.

If you told us prior to Computex that there would be a modding competition at Computex 2017 to rival the one In Win threw last year, we wouldn't have believed you. And we would've been flat wrong. The CyberMods 24hrs event, hosted by CyberMedia, invited six pairs of modders from the USA, Thailand, Philippines, Vietnam, China, and the UK to craft [most of] their mods right there on the show floor. There was cutting, painting, bending, and even a little caulking happening in the open for all to see.

The $3,000 Grand Prize, as well as the $500 Media's Choice prize that we had some input on, went to the modders from Team Thailand, for their futuristic-looking mod with a plethora of bent hardline tubing and an all-seeing laser eye. Keep an eye on team members Peerakij Rungthongkhamkul and Chaipoj Khaowasut; these guys are masters of the craft.

The $2,000 second prize went to Team Philippines, which consisted of Michael John Lanaza Lacerna and DJ Madrid for their orange and white Plexiglas masterpiece. The $1,000 third place prize went to Alexander Banks and Robert Deluce, the team from the UK, for their expertly airbrushed Terminator mod.

Although they didn't place, the U.S. team, consisting of Clockwerk Industries' James Weist and Envious Mods' Calen Saddler, carved their Thermaltake Core P5 in half to insert a massive reservoir into the middle, adorned the radiator with custom-cut decals, and created a unique acrylic Halo logo to sit atop their jaw-dropping mod. These two modders, as well as the rest of those who participated in the event, absolutely earned the right to represent their respective countries on a global stage. The modding scene is as active and impressive as ever, and we'd wager that next year, it'll be even bigger.

BUILD A RIG YOUR FRIENDS ENVY

P7-C0

PROJECT

Exploring the unknown

MID-TOWER
DUAL TEMPERED GLASS

Aero Cool
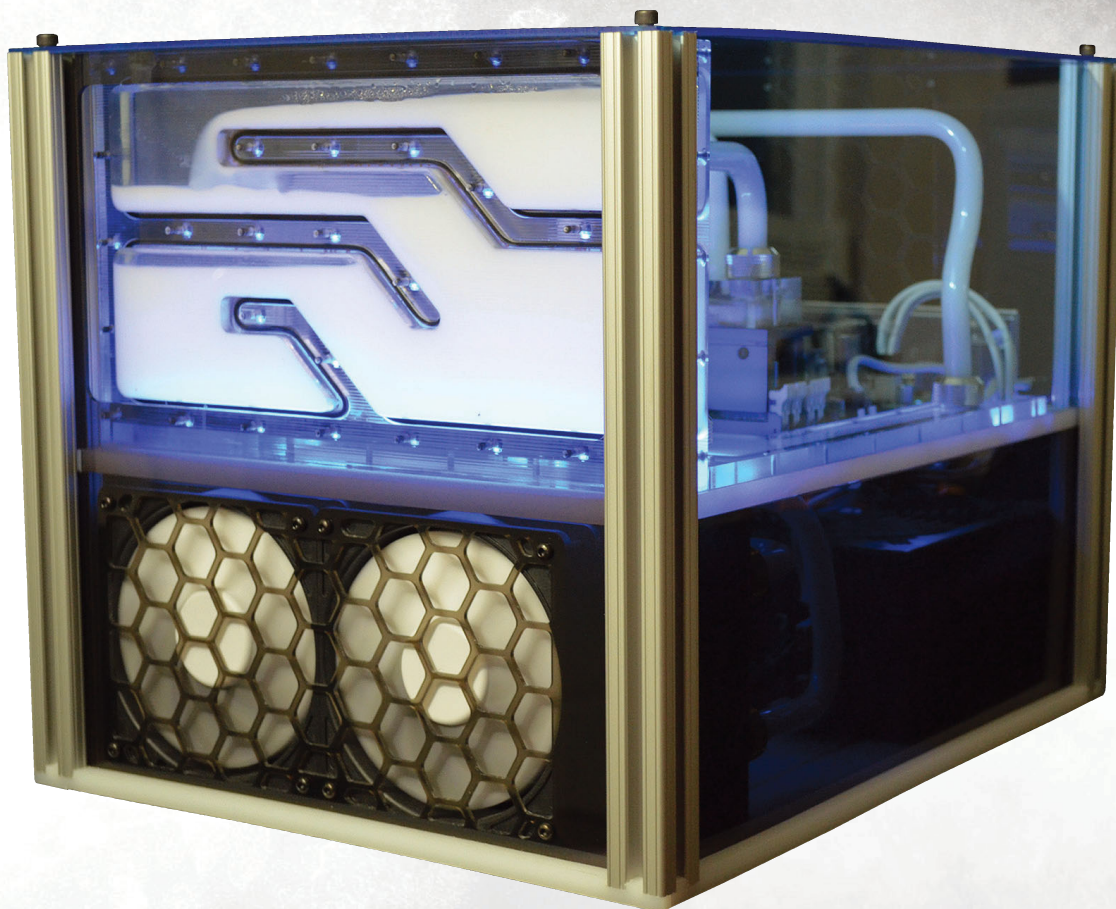
MRM ™
MAD READER MOD

Phantasm

Mario "Radikult" Rodriguez first emailed us with a Mad Reader Mod submission back in 2015; that entry was for a more "traditional" gaming PC build, and he followed up about a year ago by sending in an entry for Phantasm, the beauty you see here. We liked the way Phantasm looked, but what hooked us was the link Rodriguez sent along that took us to some of his YouTube videos where he demonstrated the process of building his custom waterblocks, designing parts for CNC construction, and so forth. (You can find his channel at www.youtube.com/channel/UC3MinCakmhnh9CJUh-TzNRw.)

Rodriguez has an easy familiarity with PC parts and construction, and his low-key style helps make his modding videos a welcome change of pace on YouTube. Before we knew it, we'd burned through his channel trailer and three of his videos—we were hooked.

Rodriguez is really good at this stuff, and what makes his skill at custom-building his own parts even more impressive is that he has no formal training—his CNC skills are all self-taught.

"I bought a small CNC machine after many failed attempts at making my own reservoir with a saw and drill," Rodriguez says. "Now, a huge hobby of mine is CNC-ing parts for my PC builds. Learning all the programs for the CNC was a challenge by itself, and after a few messed-up parts and some broken end mills [CNC cutting bits], I'm finally starting to get it right."

Brotherly Love

Rodriguez says he owes his interest in computers to his brother; his first PC was a hand-me-down 2011 CyberPowerPC rig his brother gave him, and it sparked his interest. "If it wasn't for him, I wouldn't have gotten my first PC and I wouldn't be modding PCs like I am now," Rodriguez says.

Having spent more than a decade working as a car audio installer, Rodriguez says he's spent his fair share of time dealing with wires and wire management. Thus it's no surprise that his builds are all meticulous inside and have custom-sleeved, well-managed cables. But Rodriguez wanted to expand his repertoire of building and modding skills, and liquid-cooling parts seemed like a good next step.

"I wanted to test my abilities with watercooling, and I wanted to try something that's not done too often," he says.

So Rodriguez converted a bedroom in his house into his gaming/workshop/man cave/office, and he says he pretty much lives in there in his spare time.

Phantasm

Rodriguez decided he wanted to build a PC specifically for controlling his CNC machine, so he gathered up some older parts he had on hand and then built a custom case and cooling system to house and cool them. He custom-made waterblocks for his GPU, VRM, and memory from raw aluminum and acrylic (then he anodized the aluminum
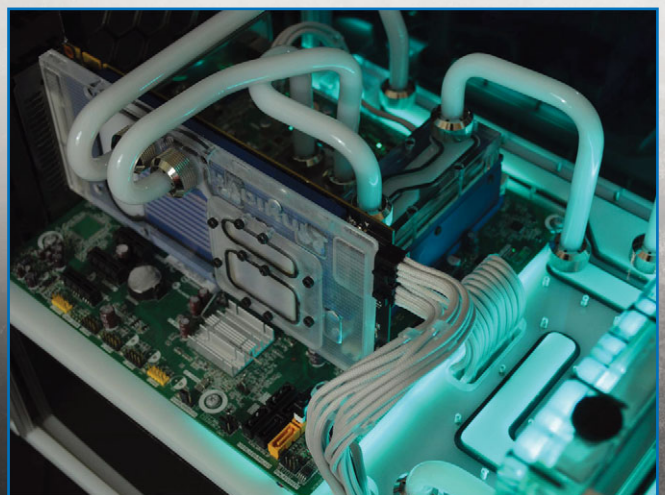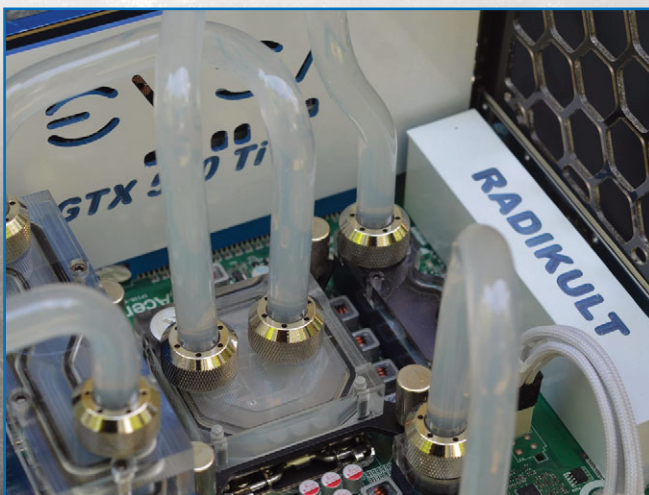
to make it non-conductive and prevent corrosion), built a custom waterfall reservoir with a built-in flow meter from acrylic, made his own acrylic side panels, and all the water channels he needed to complete the cooling system. And, of course, he built the frame of the chassis, as well.

Aside from Rodriguez's custom parts, Phantasm (a name he chose because the rig glows in the dark, and its cold, white and blue color scheme is ghostly in appearance) consists of an Intel Core i7-2600 CPU, an old Acer motherboard, 4GB of Corsair DDR3 memory, an EVGA GeForce GTX 560 Ti graphics card, a Corsair CX750M power supply, and a 250GB Samsung SSD. The rig also incorporates various EKWB and PrimoChill cooling parts to round out his cooling subsystem.

On Deck

Rodriguez says he's begun thinking about his next build, which he intends to dedicate to his brother in appreciation for having shared his interest in PCs.

"I'm in the planning stages, currently trying to figure out the details," says Rodriguez. "With the Mad Reader Mod prize money, I'll be able to buy much better components and will be able to move things forward a bit quicker."

We'll definitely be keeping an eye on the Radikult YouTube channel to see what he's up to next! ∎
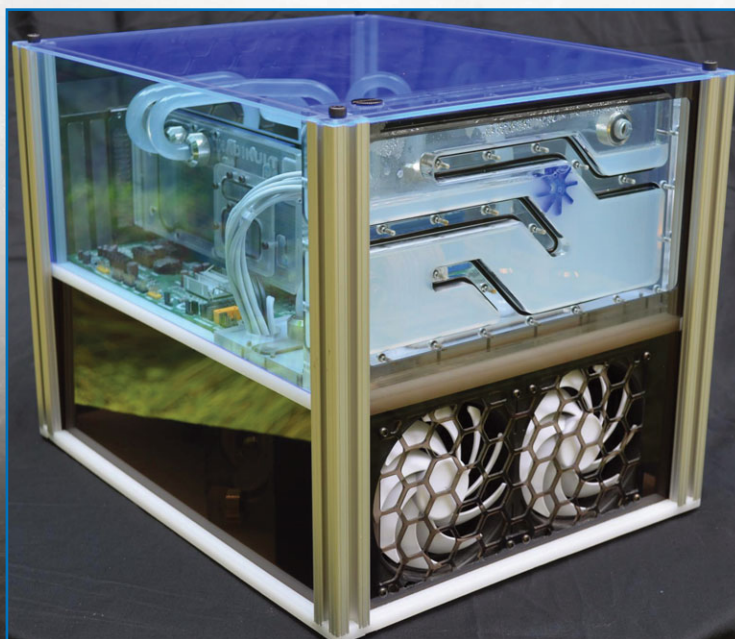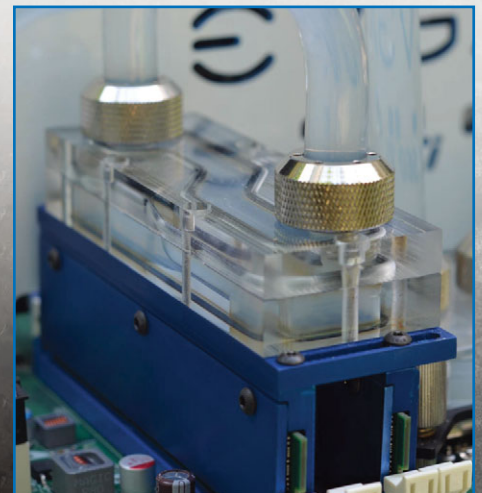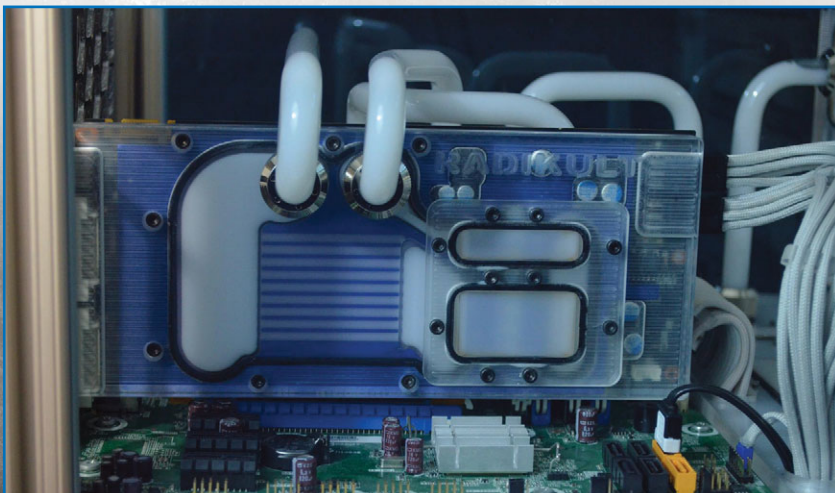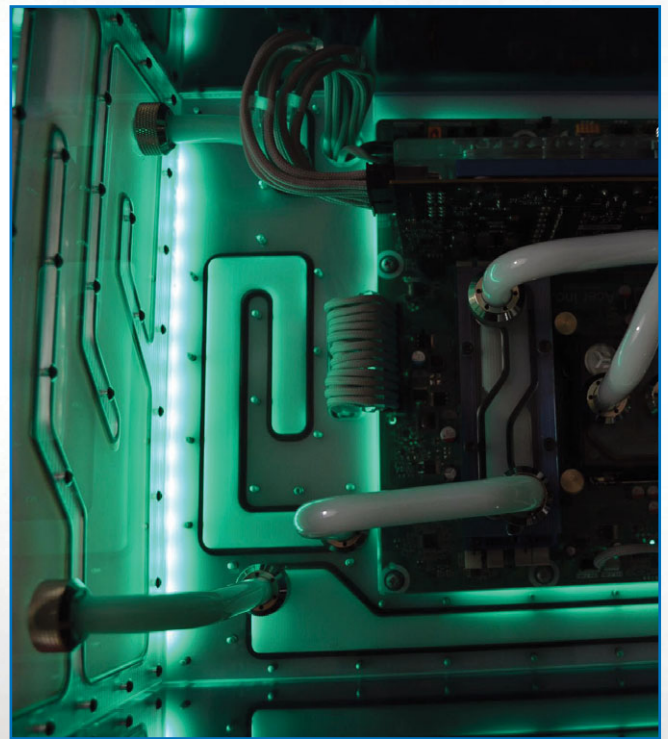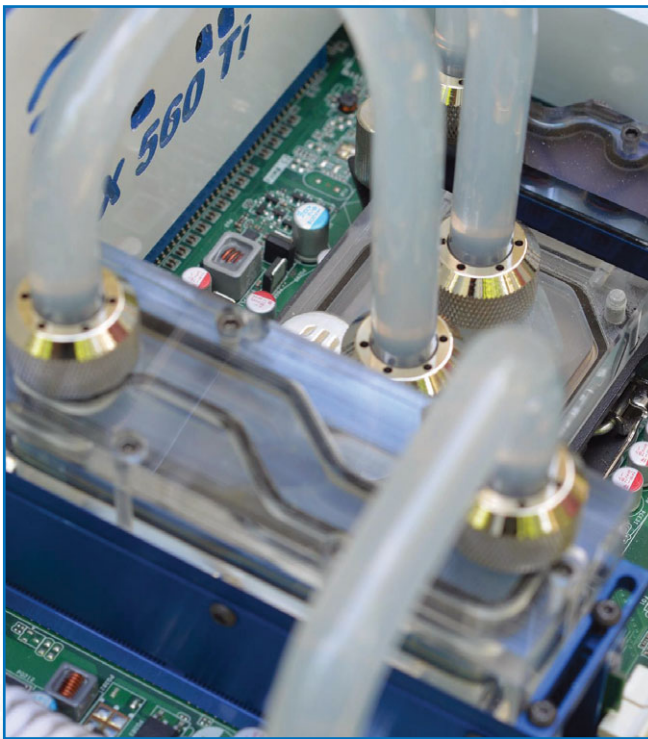
MSI Infinite A
New Rig Explores Limits Of Form & Function

The enthusiast scene moves at the speed light. Often it seems like a particular trend falls out of fashion with half of power users before the other half has even considered jumping on the bandwagon. Today's tastemakers are outdated tomorrow.

If you're ever anxious about keeping up with early adopters, imagine the cold sweats that break out among hardware manufacturers whenever one of them beats the rest to the punch and debuts a component that "goes viral." Caught off guard, copycat efforts might still be stuck in R&D while the pioneering company gobbles up market share, laughing all the way to the bank with big bags of enthusiasts' cash. This is a type of race where second or third isn't a bad finish, but contenders at the back of the pack might have been better off sitting out the race entirely.

Recently, MSI may have discovered a new way to win: Compete on a course of your own design. The curtain has lifted on the company's new Infinite A, and although we've seen its flashiest features implemented elsewhere, MSI combines them in such a manner that makes the Infinite A feel infinitely fresh. Behind that tempered glass side panel is a whole PC to explore.

Infinite Ideas

As far as gaming systems go, this isn't MSI's first rodeo. In case you haven't noticed, many years have passed since the company focused primarily on motherboards and graphics cards. Now, the stables are crowded. Enthusiast mobos and graphics cards still dominate MSI's offerings, but a whole gang of other products have entered the mix, including laptops, monitors, keyboards, mice, and even a VR backpack. As a result, MSI has developed a keen understanding of what ingredients are vital to cook up an enticing rig. To make sure the Infinite A emerged from the company lab precisely according to MSI's vision, MSI associate marketing manager Eugene Kuo says its engineers produced "at least a dozen" prototypes before settling on the final design.

"The entire out-of-the box experience is what we pride ourselves in," says Kuo. "We go from the ground up to create awesome design elements and implement the newest technologies and components.

"We wanted to create a product that had 'infinite' possibilities to play with. Whether you are someone who is looking for their first gaming PC or someone who's looking to upgrade, we wanted to cover all the bases."

Infinite Style

Visually, the Infinite A gives power users a lot to look at. Its angular front panel (including the power button) throws symmetry to the wind, and a portion of the panel has a printed circuit pattern with customizable multicolored LED lighting, offering a hint of what you can do with the included Mystic Light feature.

When the power's off, the printed circuit pattern on the Infinite A's front panel blends into its surroundings, but there's no hiding the tempered glass side panel. It extrudes slightly from the Infinite A's chassis. As cool as the tempered glass side panel is, those interested in a more traditional look will be pleased to know that MSI also includes a solid side panel with each Infinite A (rather than requiring an additional purchase for one or the other).

"Some people still prefer to have their PC internals closed up, and some want to show it off for the world to see," Kuo says.

The Infinite A isn't MSI's first gaming PC—not by a long shot—but it might be the company's coolest. Complete with a tempered glass side panel (a solid panel is also included with the system at no extra cost) and lots of LED lighting, the Infinite A is dressed to impress.

Pop off the side panel, and you'll find another one of MSI's design decisions front and center. Rather than install the Infinite A's graphics card horizontally, like the vast majority of systems, MSI opted for a vertical installation, a choice that Kuo says the company made for practical and aesthetic purposes.

"The main reasons for a vertical orientation are to eliminate the issue of the video card sagging over time and to show off the graphics card's cooler. Normally you always only see the side profile and never get to see the beauty of the cooling system. With a vertical orientation, you can show off the graphics card in all its glory."

Taking a page from case makers that have recently started adding PSU shrouds to their cases, MSI employs a shroud along the bottom panel of the Infinite A. In addition to keeping the system's power supply out of sight, the design also helps MSI create a compartmented system that isolates the hottest components and creates three thermal zones within the Infinite A.

As mentioned, MSI's Mystic Light gives power users a great deal of control over the Infinite A's LED lighting. In addition to a wide range of effects, such

Modders have been using PCIe riser cables for years to change the orientation of their graphics cards, and with the Infinite A, MSI is joining in on the fun.

as Meteor, Pendulum, and Kaleidoscope, Mystic Light presents a massive color palette to tweak the Infinite A's color scheme to each user's liking. "Everything

can easily be configured through the MSI Gaming app," Kuo adds. A 4-pin RGB header gives LED aficionados even more options.

Tough Stuff

The Infinite A's compartmented interior is one of the ways MSI builds the system for the daily punishment power users tend to put their PCs through. Under the name Silent Storm Cooling 3, MSI's system partitions the Infinite A's interior into chambers that isolate the notoriously hot components in a build, namely the CPU, GPU, and PSU. Each chamber has its own airflow, resulting in lower thermals and system noise. According to MSI's internal testing, the Infinite A is scarcely louder than a whisper at idle, peaking at 25dB, and under a full load the noise level only climbs to 36dB.

Aside from Silent Storm Cooling 3, MSI deploys more of its tried-and-true technologies to help the Infinite A take a beating. Its motherboard is littered with Military Class V components, which consist of titanium chokes (30% more power efficient by MSI's measure, helpful for overclockers and for overall system stability),

In order to keep temperatures and acoustics in check, MSI rolled out its Silent Storm Cooling 3 system, which divides up the Infinite A's interior into three isolated chambers.

BUILD TOWARD INFINITY

Infinite A Specs & Options	VR7RF-006US	VR7RE-007US	VR7RD-008US
CPU	Intel Core i7-7700 (3.6GHz base, 4.2GHz Turbo, 8MB cache, 4 cores/8 threads, 65W TDP)		
GPU	NVIDIA GeForce GTX 1080 Ti	NVIDIA GeForce GTX 1080	NVIDIA GeForce GTX 1070
Chipset	Intel B250		
Memory	16GB DDR4-2400 (2x 8GB)		
Max memory	64GB		
M.2 SSD	512GB	512GB	256GB
HDD (3.5-inch, 6Gbps SATA)	2TB	N/A (extra bay)	2TB
Max bays	2x 3.5-inch, 3x 2.5-inch (1x 2.5-inch, 1x 3.5-inch via included bracket)		
Slots	1x M.2 (auto switch, Intel Optane support)		
Networking	802.11b/g/n/ac, Gigabit Ethernet, Bluetooth 4.2		
Front I/O	1x USB 3.1 Type-C, 1x USB 3.1 Type-A, 1x USB 2.0, HDMI, audio I/O		
Rear I/O	1x USB 3.1 Type-C, 3x USB 3.1 Type-A, 2x USB 2.0, audio I/O		
Optical drive	Slim Super Multi DVD		
PSU	550W 80 PLUS Bronze certified		

Dark Caps (capacitors with lower ESR [equivalent series resistance] and a longer life span), and Dark Chokes (which have a specialized core design for even more power efficiency and stability). MSI's attention to durability extends down to the Infinite A's motherboard standoff holes; each of them is ringed with a double grounding layer to guard against electrostatic discharge.

Elsewhere, the Infinite A is built to take a hit or two (not that we'd recommend it). Its Steel Armor solder points reinforce the motherboard's PEG slot (although the vertical installation takes most of the weight off the slot regardless) and provide some shielding against electrostatic interference to the PCIe signals. Finally, the Infinite A's top panel replicates the rest of the case's asymmetrical look, but it's also hiding a secret: There's a carrying handle at the back of the panel, making it easy to haul the Infinite A to and from a LAN party.

Elite Internals

MSI has given the Infinite A a spot in its Enthusiast Gaming family of systems, which is the company's top tier, and it has the components necessary to belong there. For starters, it's equipped with an Intel Core i7-7700, a quad-core chip with Hyper-Threading that hums along at 3.6GHz. The Infinite A starts with 16GB of DDR4-2400, but you can buy more memory and stuff it in the motherboard's DIMM slots. The Infinite A's motherboard supports up to 64GB. MSI's DDR4 Boost cleans up the memory signal for—you guessed it—increased stability.

Buyers have a few choices with the Infinite A's graphics card and SSD. NVIDIA's Pascal architecture is out in force for the Infinite A, as MSI lets you choose a GeForce GTX 1080 Ti, GTX 1080, or GTX 1070. Virtual reality fanatics interested in taking advantage of one of these GPUs should be aware of the VR Link HDMI output on the Infinite A's front panel. It's a pass-through port that cables to another HDMI port on the rear panel. This setup lets you connect your VR headset to the front of the system rather than eat up precious cable length running it to the back. On the software side, MSI's One-Click-to-VR can automatically optimize the Infinite A for VR, closing nonessential programs to free up additional resources.

The system's boot drive is an M.2 SSD available in either 256GB or 512GB, depending on which model you buy. According to MSI, Infinite A models with a GTX 1080 Ti or 1070 include a 2TB hard drive, while the 1080 version lets you provide the mass storage. All models have plenty of bays to install additional SSDs/HDDs.

Onward To Infinity

Inside and out, the Infinite A is MSI's vision of what a solid, modern gaming PC should be. Any of its GPUs should let you play any game you want, and it's loaded with LEDs and other design flourishes that will definitely turn heads at your next LAN party. ∎

On the Infinite A, MSI made a small but impactful choice to give VR junkies a helping hand. In addition to the standard loadout of front panel I/O ports, there's a VR Link pass-through HDMI port.

Intel X-Series
A Tale Of Two CPUs

The X-Series processors are all big, but what lies underneath that heatspreader varies quite a lot.

The new X-Series processors from Intel consist of the Skylake X and Kaby Lake X processors. These are two very different processor families supporting a wide range of clock speed and Turbo Boost frequencies, PCIe lane counts, and core and thread counts, as well as a mix of dual- and quad-channel memory controllers. The things all members of both families have in common is support for overclocking (no "K" suffix here), the new X299 chipset, and the Socket R4 (LGA 2066). Due to the massive gulf between the features of these processors, and given the fact that–in our opinion–Skylake X and Kaby Lake X are designed for two distinct audiences, we'll be breaking this article up into two parts.

One Chipset To Rule Them All

Before we delve into the architecture specifics of the X-Series siblings, let's take a closer look at the common denominator. The X299 chipset is the central component of Intel's overhauled High End Desktop (HEDT) platform for 2017, the one that will be installed on any motherboard you buy should you choose to run the $242 Intel Core i5-7640X, the $999 Core i9-7900X, or eventually, the Core i9-7980XE, which will set you back a cool two grand. We've purchased whole CPUs for what you'll be charged for sales tax alone on that Extreme Edition processor. But we're going to leave that 18-core 32-thread monstrosity alone until it rears its head in Q4.

For now, we're mostly concerned with the chips that are slated to succeed the Broadwell-E and Kaby Lake processors. This new chipset features the same 8GTps DMI (direct media interface) 3.0 bus between the processor's memory controller and the I/O controller hub. The motherboards with this chipset will be Intel Optane memory ready, and support up to 24 PCIe 3.0 lanes, up to 8 SATA 3.0 ports, and up to 10 USB 3.0 ports (or up to 14 total including USB 2.0). On some motherboards, you will find access to up to three M.2 slots with Intel's Rapid Storage Technology. Motherboard vendors also have the option of enabling Intel Ethernet Connection I219.

The X299 chipset is tasked with juggling everything from a tweaked4-core Kaby Lake X to an 18-core Skylake X processor.

The chipset also handles I/O to SPI (Serial Peripheral Interface), LPC (Low Pin Count bus for legacy devices like PS/2, Serial, Parallel, and floppy interfaces), SMBus (System Management Bus), and the HD Audio devices. As previously mentioned, all X-Series processors are unlocked for easy overclocking, so even the entry level X299 motherboards paired with entry level Kaby Lake X processors should have some decent overclocking potential.

One thing that is conspicuously absent on any X299 motherboard you buy is the display outputs. Although we anticipated the Skylake X processors to lack integrated graphics, the Kaby Lake X processors have had theirs disabled. This isn't much of a downside for those of us who use discrete graphics cards, as most enthusiasts do, but any media encoding/decoding features of Kaby Lake that relied on the Intel Graphics Engine will not be supported on Kaby Lake X.

There's not a whole lot of standout new technologies on this chipset, but it is remarkable in how flexible Intel has managed to make the platform. If a coherent upgrade path is important to you, X299 is unique in its effective support for everything from a 4-core, 4-thread Core i5 processor with dual-channel memory and a paltry 16 PCIe lanes on up to an 18-core Hyper-Threading-enabled ultra-high-end processor with quad-channel memory and 44 or more PCIe lanes. We can't remember the last time a single socket was asked to juggle such a variety of processors, and perhaps the most surprising thing is that this series of products is coming to us from Intel.

Part I: Kaby Lake X

For Intel, the new X-Series Core processors represent the best of times, and the worst of times. On one hand, the chipmaker should be applauded for its renewed focus on the enthusiast market. By removing restrictions on the multiplier on every last one of these processors, there's nothing standing between you and a faster base and Turbo Boost frequency but a few clicks in the UEFI BIOS menu. And you don't need to spend outrageous amounts of money on a processor to join in on the overclocking frenzy.

As we went to press, the word on the street is that motherboard makers have been instructed to ensure that every X299 motherboard they create supports both the Skylake X and Kaby Lake X processors, from top to bottom. This Intel platform, which consists of a single socket supporting a wide range of processors, is something we've been clamoring for since Intel launched its first HEDT platform. We've also been clamoring for a mainstream processor that lacks the integrated graphics cores and uses that space for more CPU cores or improved overclocking. Call it a gamer's platform. By disabling the graphics cores on Kaby Lake X, Intel met us halfway.

Architecturally speaking, there's nothing much new about Kaby Lake X compared

The processor standing out front is going to be fashionably late to the party.
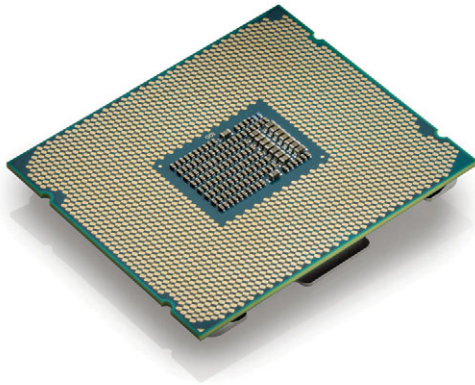
What does a Kaby Lake X do with all those extra pins?

to vanilla Kaby Lake launched at the beginning of the year besides the massive influx of pin contacts underneath the processor. Both are considered 7th generation Core processors, manufactured on Intel's 14nm node, and they both support a maximum of 4 cores and 8 threads (via Hyper-Threading). There's still 8MB Smart Cache on the i7 processors and 6MB on the i5s, support for Intel Turbo Boost Technology 2.0, and 16 PCIe 3.0 lanes. The TDP on the Kaby Lake X processors has risen from 91-watts to 112-watts, but the base frequencies are only seeing modest increases, and Turbo Boost maximum frequencies are staying the same.

Kaby Lake X is very much the gateway drug for Intel's new X-Series platform, but instead of appealing to budget enthusiasts, these processors run the risk of leaving users feeling cheated. By opting for the Core i5-7640X or the slightly more appealing Core i7-7740X, you're getting in on the ground floor of

the platform by spending the least amount of money, but you'll ultimately end up paying for a motherboard that very likely has memory, M.2, and even PCIe slots that you can't use unless you upgrade to a Skylake X processor. As long as you know this going in, and are of the mind to upgrade in a year or so, the Kaby Lake X is the ideal way

Skylake X is the shinier side of the X-Series coin.

to opt-in on a high-end platform without breaking the bank.

Part II: The Whole i9 Yards

Skylake X, the shinier side of the X-Series coin, is a lot more straightforward. This is the chip to replace the Broadwell-E Series, but it has been much expanded to include 6, 8, 10, 12, 14, 16, and 18-core processors. All of them have Hyper-Threading enabled, none of them have Intel HD Graphics. There are new features, faster memory supported, more PCIe lanes, support for Optane memory, and even some new instructions thrown in for good measure. There are Core i7 processors that fall under the Skylake X family, but also the new Core i9 series, which denotes chips with ten or more cores. The word multi-tasking is no longer appropriate, Intel refers to these processors as ideal for "extreme mega-tasking." This is a chip launch we're used to, and it's a big part of how Intel has managed to stay on top for so long.

Although we heard it from many of the motherboard vendors we spoke to at Computex, you can tell just by looking
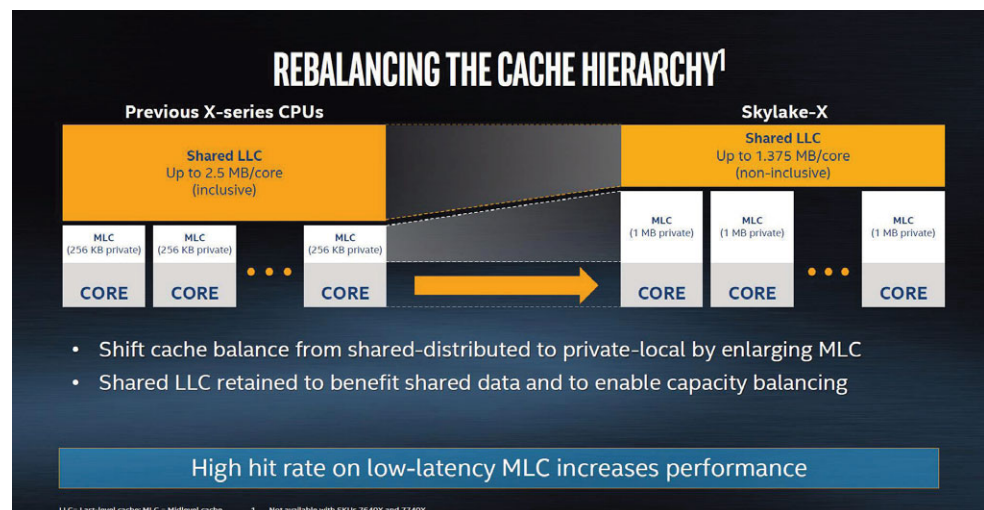

Skylake X processors got their caches rejiggered.

at the processors that are available and those that are slated to arrive in October; this is a processor launch that was rushed. We have three Skylake X processors available as we went to press, a six-core Intel Core i7-7800X ($389), eight-core Intel Core i7-7820 ($599), and a single processor that bears the i9 moniker, the ten-core Intel Core i9-7900X ($999). This lattermost processor is more than capable of outperforming the Intel Core i7-6950X, and it blissfully comes in at a significant discount compared to the older processor's $1,723 price point.

Despite the incremental upgrade that the Intel Core i9-7900X represents over the previous Extreme Edition chip, it is not the flagship. That title is reserved for the 18-core Intel Core i9-7980XE ($1,999) that we won't see for several more months. We also don't know the base clock, Turbo Boost clock, Turbo Boost Max clock, L3 cache size, PCIe lane count, memory support (though it will surely be quad-channel), or its TDP. The unlaunched 12, 14, and 16-core processors in the Core i9 family also suffer from the same lack of details.

But let's focus on the information we do have. The 6, 8, and 10-core processors in Intel's X-Series family all come with more PCIe lanes, starting with 28 on the 6 and 8-core processors, and the 10-core processor bumps the number of lanes to 44. The Intel Core i7-7800X features 8.25MB, the Core i7-7820X has 11MB, and the Core i9-7900X has 13.75MB of Intel Smart Cache. The 6-core variant is quad-channel memory capable, but the speed maxes out at DDR4-2400. This processor also doesn't support Intel's new Turbo Boost Max Technology 3.0, which boosts performance of single-threaded and dual-threaded application workloads when possible.

The 8-core and higher processors support memory clocked up to DDR4-2666, although of course most motherboards and memory
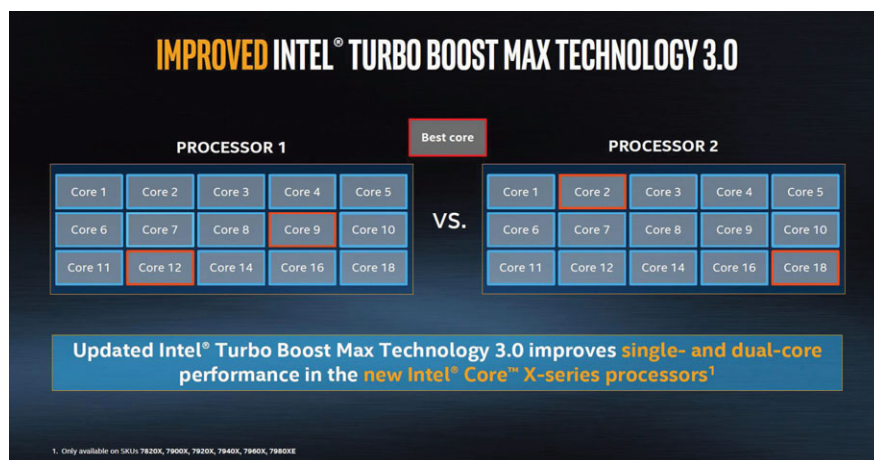
Turbo Boost Max Technology 3.0 is smarter than ever, to keep your lightly-threaded apps running faster.

vendors will get you kits that run quite a bit faster. The improved Turbo Boost Max Technology 3.0, also on the 8-core and higher processors, intelligently seeks and finds the best performing cores on the processor to boost, which means you get the most consistent speed boost possible.

The new Skylake X processors also feature a rebalanced cache hierarchy, which effectively doubles the

We can't wait to open this little black box.

private-local caches at the expense of some of the shared-distributed (non-inclusive) cache. The former MLC (mid-level cache) can yield better performance, but the shared LLC (last-level cache) is still plenty capable of performing its capacity balancing functions.

Overclockers will be happy to hear about the new AVX 512 ratio offset, memory controller trim voltage control, and PEG/DMI overclocking, which is designed to let enthusiasts push the limits of what their hardware is capable of even further. Compared to Broadwell-E, the new processors are capable of delivering up to 14% faster multithread performance and up to 15% faster single-thread performance. Of the chips you can buy today, there are up to 44 lanes of PCIe 3.0 with which to dedicate to M.2 SSDs, multiple discrete graphics cards, and ultrafast Thunderbolt 3 ports.

Although it's not available yet, we're happy to board the hype train for the Intel Core i9-7980XE Extreme Edition just to see what it looks like to run Cinebench, not to mention everything else, on a "teraflop CPU" with 18 cores and 36 threads. The one thing we know for sure is that we're extremely impatient to get our hands on it. ∎

Modder Q&A: David Cathey

A New Modder With An Old-Modder Soul

David "InsolentGnome" Cathey is a Mad Reader Mod alumnus; his gorgeous mod Shinai appeared on the cover of our February 2016 issue. We've also covered a couple of his other projects in *CPU*, including his Gigantea robot centipede mod and Twelve-80, an InsolentGnome scratch build that Cathey took with him to LANFest NETWAR 32.0 this past April. Gigantea also placed second in the Tower Mod category of Cooler Master's 2016 Case Mod World Series modding event. You can see Cathey at work on his InsolentGnome YouTube channel (www.youtube.com/channel/UCQcCQlq9O6N_7UwED4N43UQ).

Q: How long have you been modding, Dave, and how did you get started?

DC: Going on three years now. I started learning to cable-sleeve to clean up my personal computer, and then shortly after that I saw an advertisement for Cooler Master's World Series and decided that I could do that. That led to what I consider my first complete mod.

Q: What was your first mod project, and did it turn out the way you wanted it to?

DC: F3 was my first. I wouldn't say it turned out as I initially planned. My idea was just to make a clean build around the MV Agusta colors in a Cosmos SE case. I couldn't find the SE anywhere, so after some brainstorming I went with CM's Scout II and changed my idea from just a paint theme to splitting the case open and mimicking the lines of MV's F3 800. It turned out the way I wanted, just waaaayyy better than I expected and wound up taking second in the World Series that year.

Q: How many mods have you built since you got started?

DC: At this point, nine with number 10 in progress.

Cathey in the shop with his F3 mod, based on MV Agusta's F3 800.

Q: Some modders tend to stick to a particular style of mods, but the mods we've seen from you are pretty different in look and theme. Do you go out of your way to create distinct new projects, or is that just how things turned out?

DC: A little bit of both. I wouldn't say I have a hard-and-fast rule to do something different each time; my ideas have just been very different for every mod. That being said, I do like changing it up, trying a different style or learning a new skill for each new build.

Q: Your Gigantea mod placed second in the Cooler Master 2016 Case Mod World Series' Tower Mods category, right? How was that experience, and what did you learn while building Gigantea that has helped you with other mods?

Gigantea, which took second in the Cooler Master 2016 Case Mod World Series' Tower Mods category.

new Krait board and I had come up with a plan for an open bench. I wasn't happy with that idea even though I'd already ordered the materials. I mean, we've seen it done, so it wasn't very original and that's important to me so I started brainstorming. I was involved in another project that was using a single sheet of aluminum for most of the case's exterior and I liked the idea so I adopted that idea, flipped this tweaked that, moved those things, hung the hardware from the top, and boom—Twelve-80. It's night and day from the case that inspired it, but the general structure is very similar.

Q: How long have you been going to LAN parties, and how many LANFest events have you attended?

DC: I'm really a noob on the scene of both modding and LAN parties. It's funny, I've had a PC since the first optical drives came out, but my first LAN was PDXLAN's November LAN in 2015. If I'd only known what I was missing out on! I've been to two LANFest events so far, CPULAN last year and NETWAR 32.0 this spring and I'll definitely be coming back.

Q: What's your favorite game to play at LANs, and do you play in tournaments?

DC: I've been playing a lot of Overwatch lately, it's pretty much my go-to game at the moment, but I'll switch it up every now and then. I don't really get into the tournaments because I suck! [Laughs] I've got way too much of a Leeroy Jenkins mindset—rush into a fight, consequences be damned! Plus, I can get a little competitive and I go to LANs to enjoy myself, so I just hang out and check out the scene.

DC: I think grueling would be a good description! [Laughs] I wouldn't blame Gigantea for my girlfriend at the time breaking up with me, but I definitely think the time I spent on it was a factor. I learned a few technical things to get Gigantea done like metal bending and how to use the CNC table I got, and brought some other separate ideas together, like filling the legs with urethane resin to add strength. But I'd have to say the best thing I learned is if you've got an idea, go for it. Figure out how to make it work and get it done. I sat on the idea for Gigantea for four or five months because I wasn't sure how to even do it, but I'm glad I finally tried because the end result was awesome.

Q: We saw your Twelve-80 mod at NETWAR; how did you come up with the

idea for using a single sheet of aluminum for the scratch build's case?

DC: Honestly, brainstorming in the shower. I was tasked by MSI to come up with a scratch build for their

Twelve-80, a scratch build Cathey put together for MSI.

Q : What would you say is your greatest strength as a modder?

DC : That I'm totally humble, I mean, I don't like to brag and I don't like to boast but . . . just kidding. Probably my desire to be different and unique. My builds might not always be unique, but there's always a voice in the back of my head saying so and so did that on this build, you did that last time, etc. It keeps me looking for new ideas, materials, and techniques and that's good on a couple of different levels. It

A recent InsolentGnome project based on Stephen King's "Dark Tower" novels and the upcoming movie.

keeps my builds from being a rehash of previous work, but it also keeps me from getting bored with modding.

Q : What part of your modding repertoire would you most like to improve, and why?

DC : Probably two things, my artistic skill and my precision. I've just gotten into playing more with my airbrush and I can pull off weathering, but to do actual art like some of the modders out there would be awesome. Same with the

precision, I'm from the construction trades and usually if something's within a quarter-inch it's all good, but seeing someone hand file a cut 'til it's perfect . . . I just don't seem to have the patience for it.

Q : Are you working on anything at present, and if so, can you tell us about it?

DC : Case-wise, I just finished up a couple of builds for this year's CM World Series based on the Dark Tower series by Stephen King as

a salute to the upcoming movie. And I'm currently working on a demo build for MSI's PRO MOD Season 5, where I'm a judge for the contest. The theme is arctic, and my original idea was glacier-inspired, but it's since turned into a Mei from Overwatch theme. Her character fits the theme perfectly, and I have to admit, she's one of my favorite characters to play. Some of the details have also given me a good excuse to play with EVA foam from the cosplay world, so I'm really enjoying the build and learning something new.

I'm also making modding tutorials for my YouTube channel. I've started my Down & Dirty Modding series to cover entry-level topics, like hooking up LEDs, to more advanced mods, like replacing motherboard trays and making vertical GPU mounts. The hope is to give beginning modders ideas, tutorials, and inspiration to take it to that next level and to add to that knowledge base that's already available on YouTube.

Q : It's time for Five Quick Questions!

1) Threadripper or Skylake X?

On one hand, it's easy: Which one can I afford? But then again, I haven't gotten a chance to play on my new Ryzen since the build isn't finished, and I am from the Show-Me state, so my last nine years on Intel platforms makes me pretty comfortable with them.

2) Paint booth or powder coat?

Paint all the way! Mirror finishes and flame jobs FTW!

3) Kansas City Chiefs or Saint Louis Los Angeles Rams?

Are you trying to get me kicked out of Missouri? KC definitely, though I did root for the Rams when they were in STL.

4) Overwatch or Counter-Strike?

Overwatch, definitely. I'm the guy to put on a CS team in order to handicap them. I think my character in CS actually has a target on his forehead.

5) Case mod or scratch build?

I like both, but case modding is my favorite. I like the challenge of staring at a case to figure out what's hiding under its surface and then bringing that out. ∎

Pixel Perfection

Bigger, More Colorful Monitors That Redefine Your On-screen View

Monitor designs often mirror what's happening in the HDTV market, so it's no surprise that many new PC displays boast the incredible image clarity of 4K and a curved display for a cinematic view. Panel makers still incorporate the latest visual improvements, while also maintaining speedy response times, high refresh rates, and accurate color reproduction that enthusiasts demand. If you haven't upgraded your monitor recently, there are a few things you'll want consider before purchase.

Ultra HD
With a native resolution of 3,840 x 2,160, a 4K (also known as "Ultra HD") monitor has four times more pixels than a 1,920 x 1,080 monitor. The greater pixel density, much like moving from standard-definition content to HD, is a huge jump in on-screen detail. Gaming at 4K, if your GPU can handle it, is possibly the most transformative Ultra HD experience, with content appearing dramatically more lifelike.

FreeSync & G-SYNC
Although both variable refresh rate technologies were introduced a few years ago, AMD's FreeSync and NVIDIA G-SYNC finally seem to have gained traction. Both technologies avoid screen tearing effects when gaming—similar to Vsync—without introducing Vsync's characteristic stutter or input lag. Essentially, FreeSync and G-SYNC synchronize the display's refresh rate with the GPU's render rate. It's important to stress that FreeSync only works with AMD GPUs and G-SYNC only works with NVIDIA GPUs, so your monitor and GPU must be compatible.

HDR Is Coming
At CES 2017, AMD announced FreeSync 2 and NVIDIA introduced G-SYNC HDR. The two technologies are designed to deliver HDR (High Dynamic Range) metadata and tone mapping that expand color saturation and contrast. Conventional monitors with 8-bit color depth aren't really up to FreeSync 2 and G-SYNC HDR standards, so it might be some time before HDR is ready for prime time in PC monitors. Still, anyone considering a new monitor in the next few months should keep an eye on the technology.

Do More With A Big Screen
It wasn't so long ago that panels above 25 inches (measured diagonally) were cost-prohibitive. Nowadays, it's relatively easy to find 27-inch monitors that retail for less than $300. A few of the panels in our guide are huge, 35-inch displays. There's never been a better time to buy a monitor that will let you run multiple applications side by side and/or play games in cinematic widescreen.

There are a lot of other specifications, such as panel type and maximum refresh rate, that might play into your decision. The product profiles in our buyer's guide will indicate the relative strengths of each monitor.

Dell UP2718Q

$1,999
www.dell.com

Why You'll Dig It: An off-the-shelf monitor from the local big box store won't do for creative professionals. Dell's UP2718Q is a 27-inch, 4K display that is the company's first HDR10 display, and this exceptional panel also meets the UHD Alliance Premium certification. According to Dell, the UP2718Q's color spectrum supports 100% Adobe RGB, 100% sRGB, 100% REC 709, 97.7% DCI-P3, and 76.9% REC2020. Dell calibrates each monitor at the factory, and professionals can adjust display parameters using the custom color mode. To deliver accurate and dynamic color, the UP2718Q features a peak brightness of 1,000 nits and 384 local dimming zones. In addition to the brightest whites and deepest blacks, the display's color depth is also exceptional. Dell says the monitor can produce up to 1.07 billion colors.

Who Should Apply: This monitor is best suited to graphics and video professionals who need superior image quality and plan on working with HDR10 content.

Resolution: 3,840 x 2,160
Ports: DisplayPort, mini-DisplayPort, HDMI (x2)
FreeSync/G-SYNC: None

ASUS ROG Strix XG27VQ

$429 (estimated MSRP)
www.asus.com

Why You'll Dig It: ROG Strix is a brand new monitor series from ASUS, and the XG lineup is targeted at gamers. The XG27VQ, for instance, is a curved 27-inch display with a 144Hz maximum refresh rate and support for FreeSync. In addition to lag-free gaming, ASUS also includes its ELMB (Extreme Low Motion Blur) technology that increases the sharpness of objects in motion. The result, visually, is that gameplay should appear more fluid and responsive. The monitor features a resolution of 1,920 x 1,080, and the ASUS DisplayWidget lets you quickly switch display properties. The GameVisual widget, for instance, lets you pick among MOBA, FPS, RTS/RPG, Racing, sRGB, Cinema, and Standard modes. For a comfortable viewing experience, there's also a Low Blue Light mode. All ROG Strix XG Series gaming monitors feature an ASUS Aura RGB light ring, and mulitple lighting modes allow you to pick a stylish backdrop for the display.

Who Should Apply: Gamers who want a speedy monitor that also provides a panoramic viewing experience.

Resolution: 1,920 x 1,080
Ports: DisplayPort, HDMI, DVI
FreeSync/G-SYNC: FreeSync

Philips 288P6LJEB/27

$399.99
usa.philips.com

Why You'll Dig It: The 28-inch panel boasts a 4K (3,840 x 2,160) native resolution and a SmartResponse mode that delivers a 1ms response time at the more than resonable price of $399.99. The 288P6LJEB/27 also comes with Philip's SmartErgoBase that allows for height, swivel, and tilt adjustments, as well as the ability to rotate the monitor between landscape and portrait orientation. Philips includes DisplayPort, HDMI, DVI-I, and VGA inputs. The HDMI port supports the MHL (Mobile High Definition Link) standard to let the monitor display content from smartphones and other portable devices, so you can enjoy HD videos from your phone on the 28-inch screen. To let you easily connect devices, the monitor features two USB 2.0 and two USB 3.0 ports.

Who Should Apply: If you want to upgrade your gaming resolution and screen size without breaking the bank, this monitor is a perfect option.

Resolution: 3,840 x 2,160
Ports: DisplayPort, HDMI, DVI-I, VGA
FreeSync/G-SYNC: None

Lenovo Y27g Curved Gaming Monitor

$599.99
www.lenovo.com

Why You'll Dig It: $599.99 isn't exactly cheap, but considering this monitor supports G-SYNC at up to 144Hz and features a curved panel, the Y27g Curved Gaming Monitor is a good value. This 27-inch display also features a typical contrast ratio of 3000:1, and the excellent contrast combines with the curved screen to make games feel realistic. Many curved monitors use an ultrawide aspect ratio, which can sometimes result in black bars with games that don't support ultrawide resolutions. Lenovo manages to design the Y27g Curved Gaming Monitor with a more conventional 16:9 aspect ratio, so games should always appear full screen. Lenovo also installs a USB 3.0 hub into the Y27g Curved Gaming Monitor with a fast-charging port to quickly recharge mobile devices.

Who Should Apply: Enthusiasts who want a curved, G-SYNC display without spending a fortune.

Resolution: 1,920 x 1,080
Ports: HDMI, DisplayPort
FreeSync/G-SYNC: G-SYNC

ZOWIE XL2735

$699.99
zowie.benq.com

Why You'll Dig It: ZOWIE is BenQ's eSports brand and the XL2735 is one of ZOWIE's premiere eSports displays. The 27-inch, 2560 x 1,440 display supports up to 144Hz refresh rates for fluid gaming. The monitor also features DyAc (Dynamic Accuracy) technology that maintains image clarity with quick in-game movements and makes it easier to hit on-screen targets. The XL2735 comes with Black eQualizer technology to intelligently brighten dark scenes without over-exposing them—ideal for spotting enemies in dark corners, according to BenQ ZOWIE. To give you complete control over color and contrast, the XL2735 lets you adjust color brilliance with 20 preset vibrant levels. You can quickly access settings and profiles via an external S-Switch that lets you move among saved profiles, displays settings, and inputs.

Who Should Apply: Gamers who want a monitor designed for eSports that they can quickly, easily adjust for optimal settings.

Resolution: 2,560 x 1,400
Ports: DVI-DL, HDMI (x2), DisplayPort
FreeSync/G-SYNC: none

NEC MultiSync E241N

$259.99
www.necdisplay.com

Why You'll Dig It: Designed for corporate environments, the MultiSync E241N is an affordable 24-inch IPS panel with narrow (1mm) bezels on three sides—ideal for multi-monitor setups. The E241N's IPS panel helps to ensure excellent color reproduction. NEC installs a fully adjustable ergonomic stand that allows you to adjust the monitor height (up to 4.3-inches taller), tilt, swivel, and pivot. The latter lets you switch between landscape and portrait orientation in any direction. For compatibility with any system, NEC includes VGA, HDMI, and DisplayPort inputs, and the MultiSync E241N also works with zero or thin clients via an included mounting plate. An ambient light sensor inside the monitor can automatically adjust the brightness to the optimal setting.

Who Should Apply: Power users looking for a simple, inexpensive monitor that's fully adjustable to ideally fit into your home office. The ultra-narrow bezel also makes it a good option for an affordable dual monitor setup.

Resolution: 1,920 x 1,080
Ports: DisplayPort, HDMI, VGA
FreeSync/G-SYNC: None

LG 32UD99-W

$999.99
www.lg.com

Why You'll Dig It: This 4K, IPS panel is compatible with the HDR10 standard to deliver dynamic range color and brightness. Want further proof of this monitor's color excellence? LG rates it to deliver up to 95% of the DCI-P3 color space. Creative professionals will also like that the 32UD99-W is designed to work with color calibration devices, so you can fine-tune hue and brightness levels. The stunning display features an ultra-thin 1.3mm bezel to deliver a nearly borderless viewing experience. When it comes time to play, the 32UD99-W is ready, too. The monitor supports FreeSync and boasts a 5ms GTG response time. For traditional monitor connectivity, there are two HDMI ports and a DisplayPort. LG also includes a USB Type-C port that supports video at up to 4K, as well as charging (up to 60 watts) and data transmission.

Who Should Apply: LG designs the 32UD99-W to equally suit graphic artists and gamers alike, but it's best for professionals who need a 4K, HDR-ready panel.

Resolution: 3,840 x 2,160
Ports: DisplayPort, HDMI (x2), USB Type-C
FreeSync/G-SYNC: FreeSync

Viewsonic XG2530

$479.99
www.viewsonic.com

Why You'll Dig It: The XG2530 features a refresh rate of 240Hz and supports FreeSync (between 47 and 240Hz) to deliver smooth video at exceptionally high frame rates. The 25-inch eSports display also comes with preset modes for FPS, RTS, and MOBA game genres, as well as a few customizable modes, so you can create your own performance presets. Overwatch players should also like the ColorX mode preset that's tailored specifically to Overwatch gameplay. The XG2530 features Black Stabilization that intelligently scales the bright and dark levels to help avoid light blooms and shadows. Viewsonic also builds in 22 levels of scalability, so you can further control shadows and brightness. The 25-inch panel features two HDMI ports (one HDMI 1.4 and one HDMI 2.0) and a DisplayPort 1.2 port, as well as two USB 3.0 ports.

Who Should Apply: Gamers who want a speedy display that they can customize to suit their preferred game genre and preferences.

Resolution: 1,920 x 1,080
Ports: DisplayPort, HDMI (x2)
FreeSync/G-SYNC: FreeSync

Samsung C27FG70

$399.99
www.samsung.com

Why You'll Dig It: Targeted at gamers, Samsung boasts this display is the industry's first curved monitor with a 1ms response time. The C27FG70 is also a FreeSync display with support for refresh rates up to 144Hz. Maybe most impressively, this $399.99 monitor supports quantum dot technology that improves color accuracy—especially dark red and green colors, according to Samsung. The monitor's 3000:1 contrast ratio is also top notch and helps to clearly show the darkest and brightest scenes. The C27FG70 comes with several game modes with factory calibration to optimize black gamma levels, contrast ratios, and sharpness. There are FPS, RTS, RPG, and AOS modes to support a variety of game genres. To ideally position the screen, Samsung provides a dual-hinged arm that allows you to swivel, raise/lower, tilt, and rotate the panel.

Who Should Apply: Power users who want a fast, vibrant monitor that also boasts a curved screen for immersive, fluid gameplay.

Resolution: 1,920 x 1,080
Ports: DisplayPort, HDMI (x2)
FreeSync/G-SYNC: FreeSync

AOC AG241QX

$399.99
us.aoc.com

Why You'll Dig It: This 23.8-inch monitor supports FreeSync between 30Hz and 144Hz, so it can sync with a GPU at incredibly high frame rates. The speedy monitor also features a 1ms response time and a Low Input Lag mode to optimize the panel for action-packed titles. Need a gaming monitor that works as well as it plays? The AG241QX also comes with AOC's Flicker Free Technology and a Low Blue Light mode, which reduces eye strain and fatigue. To fit the AG241QX to your environment, AOC lets you adjust monitor height, tilt, and swivel. The 16:9 aspect ratio screen features a brightness of 350cd/m2 and a typical contrast ratio of 1000:1. We also like that AOC includes all modern inputs (VGA, DVI, HDMI, and DisplayPort), so you'll easily be able to connect it with any PC.

Who Should Apply: Gamers who want a speedy FreeSync panel that won't break the bank.

Resolution: 2,560 x 1,440
Ports: DisplayPort, HDMI, DVI, VGA
FreeSync/G-SYNC: FreeSync

Acer Predator Z35P

$1,099.99
www.acer.com

Why You'll Dig It: With a 21:9 ultrawide aspect ratio and curved 35-inch display, the Predator Z35P provides a massive field of view. For smooth gameplay, the Predator Z35p supports NVIDIA's G-SYNC and ULMB (Ultra Low Motion Blur) technologies. You'll want to use the ULMB mode when frame rates are routinely above 100fps, while G-SYNC is better for more graphically-demanding titles. Acer designs the Predator Z35P with a 3,440 x 1,440 native resolution, 4ms response time, 2,500:1 native contrast ratio, and a 300cd/m2 brightness—all factors that help to produce excellent image quality when gaming. The monitor stand allows you to tilt, swivel, and raise/ lower the display to find the ideal ergonomic position.

Who Should Apply: This monitor is built for gamers and movie buffs. The curved 35-inch panel provides everything you'll need for an immersive experience, whether you're playing CS:GO or Witcher 3.

Native resolution: 3,440 x 1,440
Ports: DisplayPort HDMI
FreeSync/G-SYNC: G-SYNC

OMEN X by HP 35 Curved Display

$1,299
www.hp.com

Why You'll Dig It: This curved monitor is all about immersing you in games with its 35-inch ultrawide (21:9 aspect ratio) screen and native 3,440 x 1,440 resolution. Add in support for NVIDIA G-SYNC at up to 100Hz and a 4ms response time and you've got the perfect big-screen display for stutter-free, fluid gaming. The OMEN X by HP 35 Curved Display also boasts an impressive 2500:1 typical contrast ratio for deep darks that will bring new life to dimly lit titles. Speaking of lighting, HP adds ambient lighting under the bottom bezel to help diffuse screen brightness in a dark room. HP uses an 1,800R curve (a curvature radius of 1,800mm) that matches the shape of the human eye, while the 178 degree viewing angle ensures you can enjoy the 35-inch display's full field of view.

Who Should Apply: Enthusiasts and gamers who want a curved display with a rich contrast ratio and G-SYNC to surround them with fluid gameplay.

Resolution: 3,440 x 1,440
Ports: 1 HDMI, 1 DisplayPort
FreeSync/G-SYNC: G-SYNC

Model	Price	Native Resolution	Screen Size	Ports	Response Time	Typical Contrast Ratio	FreeSync/ G-SYNC
Dell UP2718Q	$1,999	3,840 x 2,160	27"	DisplayPort, Mini DisplayPort, HDMI (x2)	6ms	1000:1	n/a
OMEN X by HP 35 Curved Display	$1,299	3,440 x 1,440	35"	DisplayPort, HDMI	4ms	2500:1	G-SYNC
Acer Predator Z35P	$1,099.99	3,440 x 1,440	35"	DisplayPort, HDMI	4ms	2500:1	G-SYNC
LG 32UD99-W	$999.99	3,840 x 2,160	31.5"	DisplayPort, HDMI (x2), USB Type-C	5ms	1300:1	FreeSync
ZOWIE XL2735	$699.99	2560 x 1,440	27"	DisplayPort, HDMI (x2), DVI-DL	1ms	1000:1	n/a
Lenovo Y27g Curved Gaming Monitor	$599.99	1,920 x 1,080	27"	DisplayPort, HDMI	4ms	3000:1	G-SYNC
Viewsonic XG2530	$479.99	1,920 x 1,080	25"	DisplayPort, HDMI (x2)	1ms	1000:1	FreeSync
ASUS ROG Strix XG27VQ	$429 (estimated MSRP)	1,920 x 1,080	27"	DisplayPort, HDMI, DVI	n/a	n/a	FreeSync
AOC AG241QX	$399.99	2,560 x 1,440	24"	DisplayPort, HDMI, DVI, VGA	1ms	1000:1	FreeSync
Philips 288P6LJEB/27	$399.99	3,840 x 2,160	28"	DisplayPort, HDMI, DVI-I, VGA	5ms	1000:1	n/a
Samsung C27FG70	$399.99	1,920 x 1,080	27"	DisplayPort, HDMI (x2)	1ms	3000:1	FreeSync
NEC MultiSync E241N	$259.99	1,920 x 1,080	24"	DisplayPort, HDMI, VGA	6ms	1000:1	n/a

Changing The Grind
Pro eSports Players Combat Injuries With Physicality

The dedication, focus, sacrifice, and physical/mental toughness it takes to become a professional athlete is no joke. A player in the NFL, NBA, MLB, or other major sport will have spent countless hours across years honing his skills to reach his sport's highest level. In this regard, pro eSports players aren't so different. True, a top-ranked pro Dota 2 player might not possess physical attributes akin to, say, LeBron James, but that doesn't mean he doesn't train as long and as intensely. He just does so differently.

"People will argue whether or not eSports deserves to be considered a 'real sport' when compared to other traditional sports," says Robert Yip, head coach of pro eSports team Immortals. Considering the "inhuman levels of speed and power" major traditional sports demand of players, he says, it's a difficult argument to make. Instead, Yip places eSports closer to such fine-motor-control sports as archery, snooker, darts, and pistol shooting where fast micro-movements and top-level hand-eye coordination "propel good players to the elite level."

eSports pros execute these micro-movements on controllers, keyboards, and mice repeatedly for eight-plus hours essentially daily when preparing for upcoming tournaments, many now touting prize pools in the millions. As Dr. Caitlin McGee—a gamer, physical therapist who consults with eSports players, and operator of PlayMoreHurtLess.gg—explains, that's a day's worth of "precise, repetitive motion performed in positions that apply stress." Over time, that can lead to serious hand, neck, shoulder, wrist, or other injuries without proper preventative measures.

Injuries are a growing concern in eSports, in part because they've forced many top-ranked players to stare down retirement while still in their 20s. Positively, eSports teams and players are

In a relatively short time period, professional eSports has exploded in popularity to the point that fans are packing major arenas to watch tournaments, prize pools are reaching into the millions, and players are gaining sizable social media followings.

With so much now at stake for professional eSports organizations, teams are hiring more specialists to enhance player performance. These include nutritionists, physical therapists, and performance coaches.

taking steps to address injury risks, as well as to address the mental fatigue and general burnout that unrelenting, intense practice sessions; extensive travel; and scads of external obligations can bring. Beyond embracing healthier lifestyles through exercise, forced periods of rest, and proper nutrition, teams are hiring performance coaches, nutritionists, physical therapists, and other support staff to bolster players' overall health.

"A performance coach helps prepare the players physically, mentally, and emotionally for the toils of competition," says Yip. "Professional gamers must dedicate the majority of their waking hours to playing the game to maintain a competitive edge." Improving daily activity, nutrition, and mindset can alleviate and control possible burnout, dips in form, and injury, he says. "The performance coach has to take care of everything outside of the game for the team/individuals and try to make sure that players buy in with the team's vision." The following explores the influx of performance coaches in professional eSports, players embracing healthier lifestyles, injuries, and more.

The Game Has Changed

Why do eSport players practice to the point of their own detriment? Simple. There's an incredible amount of money, fame, and pride at stake. Currently, interest and money is pouring into eSports from all corners, including from other sports leagues, game publishers and developers, and television and Web broadcasters. Moreover, the eSports fan base continues to mushroom, leading to packed arenas, merchandising profits, endorsements, and players building impressive personal brands via Twitch and YouTube channels. To get an idea of the landscape pros operate in now, consider these stats from various sources:

- eSports is projected to generate about $700 million in revenue this year and reach about $1.5 billion by 2020
- Those who view game videos and live streams online (665 million) outnumber the U.S. population (325 million)

- Twitch viewers (185 million) now outsize HBO subscribers (134 million), Spotify users (100 million), Netflix subscribers (93 million), and ESPN subscribers (90 million)
- 5 million more viewers watched the 2016 League of Legends World Championship (36 million) than 2016's NBA championship
- eSports is predicted to account for 10% of all U.S. sports viewing by 2020

In short, eSports is now a land of ever-increasing opportunity for pros. In May, for example, the NBA and Take-Two Interactive announced a new NBA 2K eLeague to launch in 2018, making the NBA the first traditional sports league to directly enter the eSports space. Take-Two Interactive CEO Strauss Zelnick stated "the financial consequences could be substantial." Initially, 17 NBA franchises will participate, reportedly to the tune of $750,000 each over three years. Previously, however, the Philadelphia 76ers and Miami Heat bought ownership

stakes in the Team Dignitas and Misfits eSports teams, respectively. A handful of NBA team owners had also previously invested in pro eSports teams. The 2K eLeague will involve a draft of eSports players, who will receive salaries and training as part of the deal.

Other recent developments include PlayStation Vue Elite and Ultra subscribers gaining 24/7 access to an eSports TV channel from ESL. Last spring, Twitter announced it would live-stream 1,500 hours of action from more than 15 events via deals with ESL
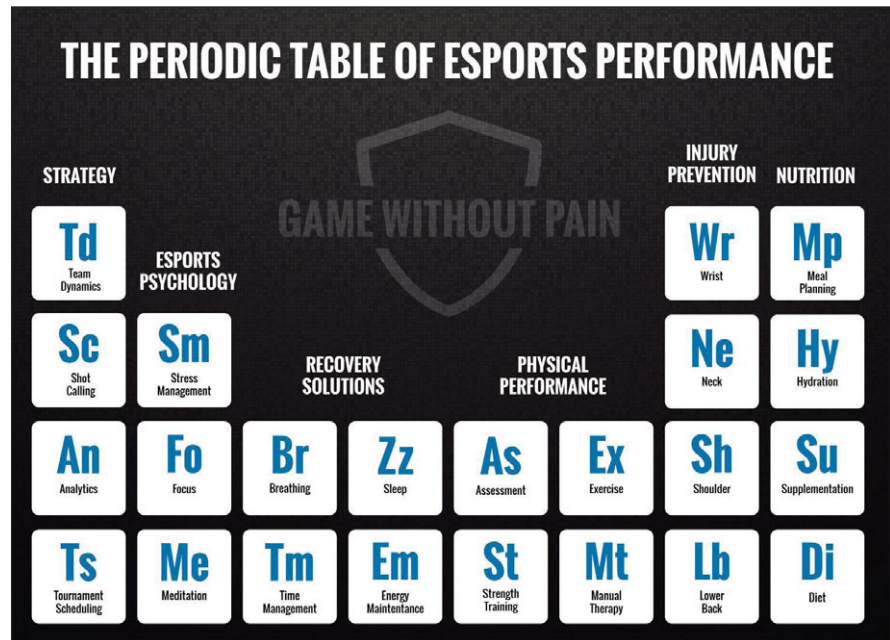
A "Periodic Table Of eSports Performance" chart designed by Ben Jackson, a former eSports competitor who retired due to injury before becoming an eSports performance coach, details key components for 360-degree training of eSports pros, including ones related to recovery solutions, physical performance, injury prevention, and nutrition.

and DreamHack. Elsewhere, Rocket League creator Psyonix recently inked a sponsorship/advertising deal with the WWE that will put the Rocket League brand in front of the WWE's sizable audience. Another deal with NBC will see a Rocket League 2v2 tournament happening this summer with a $100,000 prize pool and footage to air on NBC Sports Network and the Syfy Channel.

Riot Games, the force behind League of Legends, meanwhile, recently detailed

a new franchising model planned for the North American LCS. Reportedly, the new model will involve 10 teams paying a $10 million franchising fee each. Bloomberg reported that for gamers, the move is a "long-awaited sign that the industry is growing up," while for outsiders, "it's an indication that there's a real business here." As Bloomberg reported, not long ago, LoL teams typically sold for about $1 million. The new model will notably include a players association and team revenue sharing. The latter will reportedly give Riot Games and team owners a 32.5% slice of revenue and players 35%. Whalen Rozelle, Riot Games' co-director of eSports, stated Riot believes "this process will actually spur on the old-school eSports guys to join forces with new investors to create new organizations that should have the best of both worlds."

The Art Of Coaching Performance

With more riches up for grabs, eSports pro teams are increasingly integrating specialty coaches and staff to support players. These include cooks, nutritionists, trainers, physical therapists, and performance coaches. "Many of the top-performing teams have a much larger support staff on average," Yip says. "These teams are more willing to invest in consultants or full-time coaches to help their players perform at a higher level." Yip says knowing they have multiple people with expertise in given fields pushing them to achieve their goals has given players confidence. He adds that players have publicly sung the praises of strength and conditioning coaches, physical therapists, and sport psychology trainers for helping them play at higher levels.

## The Merits Of Preventative Stretching

On her website PlayMoreHurtLess.gg, Dr. Caitlin McGee writes that the more time that's spent on activities that require repeatedly executing the same movements—particularly small and precise ones—"the more likely you are to get injured. It's a simple numbers game." McGee, a physical therapist who consults players, offers numerous videos, guides, articles, and other resources on the site concerning gaming-specific ergonomics and injury prevention.

An article she penned called "How To Save Your Hands, Your Back, and (Maybe) Your Stocks" details hand, wrist, back, shoulder, and other stretches suited for PC and console gamers. With any videogame, she writes, ergonomics plays "an enormous role in preventing injury." While ergonomic setups for PC gamers are generally clearer, matters are trickier for controller gamers, as "it's a lot harder to sit fully upright and still have your hands/arms supported in a comfortable position" if not using a lap desk tray or similar object.

For heavy-duty controller users, back and neck stretches are key to avoiding pain over long tournaments and to preventing long-term stress. McGee provides illustrated stretches targeting these areas. She notes, though, the stretches "everyone REALLY wants to see" are those targeting the hands and wrists, for which she also provides illustrated stretches.

In a "Treat Yo Self: Choosing Treatments For Self-Management Of Injuries" article, meanwhile, McGee outlines common methods to address gaming-related strain, including:

Ice. "The right choice" to address pain connected to inflammation and swelling vs. heat, which causes "more inflammation, not less"; use for 20-minute periods.
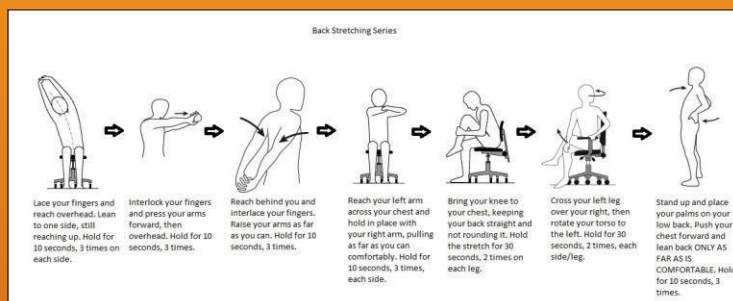
At her website PlayMoreHurtLess.gg, Dr. Caitlin McGee makes scads of resources available that detail proper ergonomic setups for eSports players, including articles and illustrated guides concerning stretches she recommends players use.
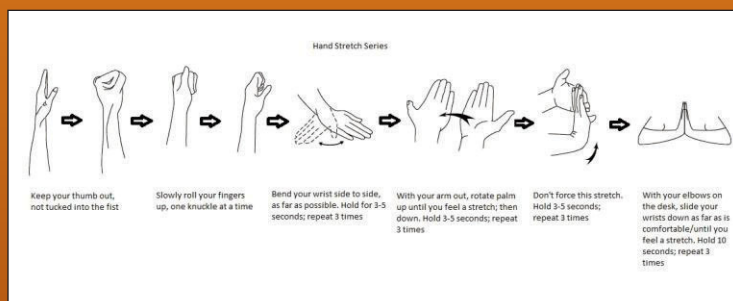
Heat. Use heat to deal with pain associated with muscular tension or tightness; apply for 10- to 15-minute periods.

Stretching. Limbering up helps address muscle-tension issues; never stretch cold muscles; hold individual stretches for 30 to 60 seconds.

Massage. Particularly useful for difficult-to-stretch muscles (back, wrist/finger extensor muscles in forearms, and palmar muscles of the thumb); foam rollers, tennis balls, and trigger point canes are self-massage options.

Michael Schwartz, head of player development for CLG (Counter Logic Gaming), says performance coaches and sports psychologists have spiked in popularity due to the increasing demands and stakes of competition. "Organizations no longer see this position as a luxury with the demands on athletes, especially younger ones, who need to maintain any edge over the competition and stay in the game longer by reducing burnout," he says. For players, he says, anything that improves their training quality and efficacy is a boon. Often, a performance coach who enlists a proper regimen is what's needed to unlock a player's abilities. "Once they begin to see these results, the athletes are much more inclined to continue with such coaches," he says.

Overseeing training is one of a performance coach's most important duties. Currently, it's overtraining-related issues that are arguably impacting the health of eSports pros the most. Physical symptoms (wrist and forearm pain; eye strain; back, shoulder, and neck issues) caused from hours of sitting and gaming are easiest to identify, Schwartz says. Mentally, however, overtraining manifests as burnout, general avoidance of the game, and decreased performance. "The reasons we see these issues at all, compared to traditional sports where these are less prevalent, is due to the ease of overtraining to reach a performance goal," Schwartz says.

Unlike an NFL player who can only push his body theoretically to a point where it can no longer achieve optimal results, eSports players can continue past this point without effects becoming immediately clear, Schwartz says. "Many athletes conflate this overtraining for improved performance, and indeed it might result in short-term gains but [also] long-term destruction of their mental and physical health and ultimately their exit from the game," he says. Beyond long practice sessions, the sheer amount of tournaments and games eSports pros play, along with "living and dying by the rankings," can propel them to constantly push their bodies and minds past what's safe. It doesn't help that there's a general lack of education about consequences of overtraining players.

Are eSports Pros "Real Athletes"?

Whether pro eSports players are "real athletes" similar to pro basketball, football, and baseball players is hardly a new debate. Although opinions vary, there are undeniable differences in size, strength, speed, and other physical attributes between the groups. That said, German Sports University Professor Ingo Frobose found that where the demands athletes face in order to compete and where the strains they experience while competing are concerned, eSports pros are very much like their counterparts.

Last fall, Frobose and colleagues released results of a study they conducted to explore the level of "chronic and acute stress" present in eSports training and competition. (German news site DW.com reported Frobose is believed to be the first scientist to conduct such studies concerning eSports pros.) To do so, the team put members of a German CS:GO team through various tests. Reportedly, Frobose was particularly impressed with the demands eSports places on players' motor skills. He noted eSports players achieve up to 400 keyboard and mouse movements per minute, four times that of the average person. He also stressed that eSports players move both hands and various parts of their brain simultaneously. The level of strain this introduces is unlike anything Frobose said he'd witnessed in other sports.

Frobose's tests also measured for the stress hormone cortisol, which he discovered eSports pros produce on a level equal to race car drivers. He also found players' pulse rates sometimes hit 160 to 180 bpm, roughly equivalent to what a very fast run would generate. "That's not to mention the motor skills involved," stated Frobose. "So in my opinion, eSports are just as demanding as most other types of sports, if not more demanding."

Less positive, Frobose also found most eSports pros don't prepare for competition in a professional approach in terms of nutrition and physical training. "They simply aren't fit," he stated, including because they don't do exercises that would enhance shoulder and neck areas, which in turn would improve fine-motor skills in their arms, something Frobose says is "extremely important in competition."

"In traditional sports, the dialogue is concerned with the health of the athlete to perform, therefore while one pushes to the point of pain, time and resources are dedicated to recovery, as well," Schwartz says. This dialogue is becoming more mainstream in eSports, he says, and athletes are choosing to train smarter as more performance coaches and other professional sports organizations enter eSports.

Yip says eSports teams are generally seeking coaches who possess a decent understanding of the eSports league they'll work in, which helps bridge the gap between eSports and traditional sports. "Not many pro gamers have extensive knowledge of the practices being implemented within the teams, so creating practical solutions requires some creativity," he says. "Not all players will buy into what's being presented, but generally, teams/coaches and owners want

to see their investment grow and become more sustainable."

Schwartz says theoretically if a player could train at 100% efficiency 16 hours a day, he'd eventually become the best player in the world. Most pros, though, practice six to 10 hours daily and not at 100% efficiency, he says. "Why not invest the time, which may amount to only a few hours per day, to fuel your body properly, keep it in shape and functioning at 100% so you can practice and perform at that level consistently?" he says. To prepare for long best-of series players, Schwartz says training largely includes endurance training and preventative care against physical problems. "Higher sets and repetitions in the gym and additional focus on stretching, especially relative muscle groups in the wrists, forearms, neck, and back, can ensure that the

athlete gets to focus solely on the game, not the pain," he says. Most CSL players hit the gym three times a week or do physical activity and stretching daily.

Mentally, Schwartz says having standard pre- and post-game procedures and review processes in which players can vent frustration constructively helps

The Professional Way To Improve Gameplay

When William Collis, Rohan Gopaldas, and Jiapeng Ji were looking for feedback that would help them improve their Hearthstone gameplay, they found the streams and forums available online weren't all that helpful. Moreover, they hated those times when they played for hours but failed to learn anything or, worse, exhausted an entire night with nothing to show for it but losses. As Collis told ESPN, his buddies basically kicked him out of their Hearthstone group because he was so bad. "I was using all the resources available to me at the time, Twitch streams, deck guides, and nothing was working," he says.

Eventually, the trio's frustration led them to launch Gaming Sensei, dubbed "the first mastery platform for competitive gamers who want to win more." The platform—which has received about $2.3 million in early backing from investors—uses a proprietary algorithm that matches a player seeking guidance with a coach identified as possessing high-level skills in the player's game of choice. Currently, coaches are available for Hearthstone, Overwatch, League of Legends, Dota 2, Heroes of the Storm, and StarCraft II. Gaming Sensei's Dota 2 coaches, for example, include formal Cloud9 instructors and globally ranked pros. In terms of learning, coaching in League of Legends, for example, includes "everything from champion tutorials to advanced role and tournament strategies."

In early June, Gaming Sensei added a new element to its platform via an exclusive partnership with H2K Gaming that makes receiving personal instruction from H2K Gaming's pro LoL team possible. Expect to pay $50 to $60 for the lessons. The partnership will also see various coaching sessions streamed on the H2K pro's individual Twitch channels. Further, Gamer Sensei will reportedly compile best-of highlights videos for its YouTube presence, and H2K's pros will also host videos featuring tutorials, mid-game failure compilations, and other footage. Gamer Sensei COO Jim Drewry stated that the ability for H2K fans to learn firsthand from their favorite H2K player "supports our goal of connecting eSports pros with competitive players who want to learn from the best as they master their favorite game."

Coaching has become key to the success of professional eSports teams. Gaming Sensei, however, wants to make high-level coaching accessible to anyone who wants to improve her gaming performance.

alleviate tension that can build during practice. Weekly educational and team-building activities and exercises also reinforce good communication and a strong team environment. "Overall, the mental training regimen is going to depend on what the team needs, but in most cases, having a set protocol on how to interact is the most conducive thing in the training regimen for practice. And then we include visualization, anxiety- and stress-reduction techniques, and individual and team goal-setting to sharpen up the remaining flaws," he adds.

Schwartz cites CLG members FNS and reltuC as specific examples of players who invested the time to get physically and mentally healthier through multiple weekly gym workouts and work concerning performance anxiety, better leadership, and improved communication. "You could see it in our most recent series against Fnatic at DreamHack Summer where we played a grueling 59-round match into quintuple overtime, and these players, especially FNS calling, kept composure the entire time and were able to lead the team to victory," he says.

The "team house" is another trend teams are embracing to enhance performance and team chemistry and communication. Here, players and staff live, practice, and train together in one residence. Almost every pro eSports team operates out of one now, Yip says. "Having everyone living in the same house makes it easier to get everyone on the same routine, while also increasing their ability to come together as a single unit," he explains. "Players will partake in team activities and experience the same environment while working and socializing together. This helps coaches for exercise prescription, keeping track of daily nutrition, as well as keeping regular sleep schedules."
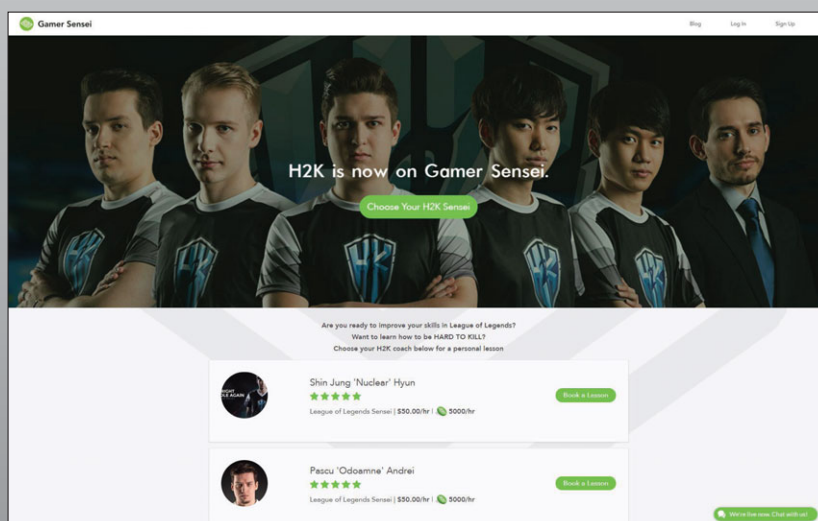
No Pain, No Game

Stories of eSports pros who had to temporarily or permanently step away from competition at young ages due to injury are unfortunately common. Going back several years, top-ranked players who've had their careers interrupted

or derailed have included Lee "Flash" Young-ho (StarCraft II; wrist); Jung "Mvp" Jong Hyun (StarCraft II; neck, shoulder, arms); Clinton "Fear" Loomis (Dota 2; arm); and Daniel "KDJ" Jung (Smash Bros Melee; tendonitis). The most well-known example may be Hai "Hai" Lam, a top Cloud9 LoL player who retired in 2014 at 22. In a statement, Hai wrote he could no longer ignore a wrist injury that limited his "ability to play as much as I need to and my ability to improve." In 2016, he was able to return to action.

"The injuries we see most commonly are overuse injuries," says McGee. "Unsurprisingly, there are nerve-related issues, like compression at the elbow or at the carpal tunnel, but a significant amount of issues related to mobility, like tendon gliding in the fingers/knuckles, as well. In addition, tension and trigger points in the wrist extensors and upper back muscles are fairly common." McGee says while watching a player from any sport walk away from "the thing they love doing" because of injury is tough, it's even tougher in eSports because typically the injury could have been prevented, unlike with some injuries in contact sports out of the player's control.

McGee is one of relatively few medical professionals with a notable presence in eSports. Another is orthopedic surgeon Dr. Levi Harrison. In a Motherboard.com article, he said he wished eSports players who retired due to hand issues had seen him first. "Maybe we could have worked out a strategic, focused therapy plan to help them," he said. "So often, many healthcare providers will tell a gamer 'Oh, just stop playing and you'll be OK,' but that's not true. They already developed a problem."

In an AS.com article, physiotherapist Jose Feito detailed how eSports injuries occur, saying, "Muscle tissues adapt to the work that is asked of them. But to perform actions in a repetitive way, as is the case with electronic sports, this takes the body to its limit. It's similar to what MotoGP riders suffer; they spend hours squeezing and braking, a seemingly harmless gesture, but something that

The eight to 12 hours of practice that most eSports pros put in daily leads them to making countless keyboard/mice or controller movements, routines that can and do lead to serious arm, wrist, and other injuries. Such injuries have forced numerous top-ranked players to retire or temporarily step away from competition. Perhaps the most well-known example is Hai "Hai" Lam, a League of Legends champion.

does not allow the muscle to oxygenate." Feito also explained the importance of good ergonomics in terms of sitting properly and not damaging intervertebral discs. "These fashionable rally chairs are comfortable, but they may not be suitable for long gaming sessions," he said.

McGee says she started working with eSports players around the time people starting taking injuries seriously. "Teams are becoming more invested, and players are realizing more and more the importance of prevention," she says. She adds that more players are taking personal stock in their health with support from their organizations. "We're developing a level of professionalism in eSports—not the kind of boring professionalism that means no more trash talk and banter—but the kind of professionalism that recognizes, 'This is a career. This is how I make a living. I need to protect that.'"

McGee points to Matt Hwu—head of physical performance and eSports medicine for CLG and someone she works with via Hwu's 1HP Gaming—as also bringing awareness to eSports injuries. "Cloud9 has a physical therapist, as well," she says. "ProDota has worked with another exercise physiology professional, so there's definitely an awareness in the scene and a desire to preserve careers by taking this preventive care seriously."

On his website, Hwu says he made a career in gaming and wellness after noticing how little pro and hobbyist gamers knew "about their own bodies and how to manage their health." Hwu discovered "when I stalked gaming forums, subreddits, and even watched some professional gamers stream, there was a very obvious lack of knowledge with regards to fitness and health management." Hwu makes available a free "The Gamer's Guide To Managing Carpal Tunnel Syndrome" ebook and articles about what to know about exercise and injuries on his site. For injuries, he outlines five main topics of interest: rest, prevention, exercises, addressing the pain pattern, and self-massage.

McGee says the most ergonomic setup players can have is one that fits them individually vs. one with the most expensive/fanciest gadgets and peripherals. She also stresses it takes significantly less time to prevent an injury than recover from one. Finally, she recommends establishing good habits before pain even starts by taking breaks, using ice/heat appropriately, and performing stretching and strengthening exercises as is appropriate. ∎

CPU
Game Of The Month

Yeah, we know you have blogs to post, video to encode, reports to write, and code to compile. We do, too, but you have to take a break once in a while (and maybe blow some stuff up). That's why each month we give you the lowdown on what to expect from the latest interesting games.

RiME™

Short But Very Sweet

BY CHRIS TRUMBLE

$29.99 (PC, XOne, PS4) • ESRB: (E)veryone 10+
Grey Box • www.greybox.com

This is a great time for gamers who enjoy indie games that are a little shorter than most triple-A games from major publishers—and games that cost less, too. Case in point: This month's Game of the Month, RiME, a third-person adventure game from Grey Box and developers Tequila Works.

Although RiME mostly takes place on land, that land is a deserted island seemingly located in the midst of a vast ocean, and as the game progresses, the player discovers that the sea plays a large role in the game's story. In some ways, the game hearkens back to Coleridge's 1798 poem "The Rime of the Ancient Mariner." It's the story of a young boy who wakes up on the shore of a desolate island, and what he finds as he explores it. There's quite a bit more to the story, of course, but letting it develop naturally is a big part of enjoying this game, so I won't offer any spoilers here.

RiME is a strikingly good-looking game, full of diverse environments crafted from beautiful, hand-drawn art, and accompanied by a soundtrack that evokes a wealth of emotion and also guides you as you play. When you wander from the "correct" path, the music goes into a holding pattern and grows quieter, but swells once more as you begin to find your way. It's a subtle but highly effective design mechanic, and along with the guidance of the boy's only friend on the island, a small red fox, helps to keep players on track in the game's fairly large, sprawling levels.

Gameplay is pretty straightforward; RiME doesn't include combat, choosing instead to encourage players to avoid danger, and rewarding exploration of the island by awarding astute players with several types of collectibles. You'll find a child's toys hidden here and there, and they play a small but impactful role later in the game. You will also find emblems, alternate outfits, lullabies, and keyholes hidden around the game; the keyholes let you glimpse scenes that seem to impart snippets of information about the boy's past.

You'll run, climb, jump, and swim in the process of discovering this game's secrets, and there's also a rather novel mechanic that lets you activate certain items around the island by shouting at them. There's not a single word of dialogue from start to finish, but the boy's responses to the world around him often speak volumes, and as the game progresses, you will observe as he regains crucial snippets of memory that help to reveal his story. Where is this island, and how did the boy reach it? Who is the mysterious figure in a red cloak that you catch a glimpse of now and then? The answer to these questions and more are revealed as you play RiME, and it's a journey that's well worth the time.

Speaking of time, it took me a little over eight hours to complete RiME the first time, but it could easily take determined players (who are also good puzzle solvers) an hour or two less. Conversely, it could take you two hours more or longer if you are determined to find all of the game's collectibles; I found fewer than half initially. There are also a number of achievements/trophies hidden in the game, but playing through RiME from start to finish is reward enough in itself.

You can currently play the game on PC, Xbox One, or PlayStation 4, and a Nintendo Switch version is set to be released in December. ∎

Cashing In On Nostalgia

BY ANDREW LEIBMAN

$39.99 Upgrade, $59.99 Standalone (PC, XOne, PS4)
ESRB: (M)ature   •   ZeniMax Online Studios
www.elderscrollsonline.com

It was two years ago when I finally waded through the opening chapters of The Elder Scrolls Online, and that was following the Tamriel Unlimited update that was designed to shed at least a little of the game's MMO-ness in favor of a more approachable solo experience. At the time, I concluded that players who were looking for "Skyrim with Friends" would ultimately be disappointed to find little more than a bland MMO that takes place in a vaguely familiar setting.

The Elder Scrolls III: Morrowind, a game I sank hundreds of hours into in 2002, is largely responsible for the culture shock I felt while playing The Elder Scrolls Online: Tamriel Unlimited. Morrowind was more than a genre-defining RPG, in this reviewer's mind, it was one of the best games ever made. Full stop. Even Oblivion and Skyrim, the subsequent Elder Scrolls chapters that I loved playing, never absorbed me quite as deeply as Morrowind. It was a game that let me become a hovering firebomb-hurling god-wizard with green skin and tusks. It's true, I was untouchable and the game was effectively broken as a result, but I felt like I had earned my godhead, through digital blood, glitched-out sweat, and wonky-combat-induced tears.

ESO, by contrast, asks you to buy an add-on to join the Thieves Guild. Want a house to store your armor and fancy weapons? You gotta pay real money for that, too, in the form of Crowns, and the most modest homes will cost you more than $30. Oh, there's an option to use in-game currency, but good luck earning the 1.3 million Septims on an Orc warrior's income. Want to furnish that house? Cha-ching! And unlike in every single-player-only Elder Scrolls title, there's a limit to how much stuff you can store in a barrel, chest, or armoire, so a modest home really will limit your virtual housing experience.

It's the same story for acquiring a horse or other mount. Your inventory is also limited to 60 items, and if you want to do any crafting, each unique item takes up a slot. Gamers who paid $59.99 for the base game and another $39.99 for the Morrowind expansion will constantly be harangued for more money just to play the game the way they want to. The answer to all this money-grubbing madness is to simply become an ESO Plus subscriber, for $14.99 per month, which results in 10% faster levelling, a steady stream of Crowns, an infinitely deep bag for crafting supplies, and the ability to install more furniture in your home.

There is value in being able to wander docks of Seyda Neen, visit the giant mudcrab carcass of Ald'ruhn, explore the massive inhabited mushrooms of Sadrith Mora, pay your respects at the feet of Azura, or get lost in the winding ashen paths of the Red Mountain, once again, in a modern game.

But no matter how much they dress it in Morrowind's finery, The Elder Scrolls Online is just an average MMO trying to cash in on my favorite franchise. I imagine the only way to really enjoy this game and its many expansions is to buy it, and then drop another $80 on a 6-month ESO Plus subscription. I have to say "imagine," because there is no reality where I am willing to pay $180 for a gaming experience. Call me old-fashioned, but I think I'll just reinstall Morrowind and try out some of these mods I keep hearing about. ∎

See No Evil, Hear LOTS Of Evil

BY VINCE COGLEY

$22.99 (PC, XOne, PS4) • ESRB: (M)ature
Feardemic • www.thedeependgames.com

On paper, Perception has all the makings of the sleeper hit of the summer. It's a horror game with a clever, original concept—possibly a game-changer in a genre that sorely needs one. The crew of the indie developer that put the game together has collectively cut its teeth on such landmark titles as BioShock, Rock Band, and Dead Space. Thousands of Kickstarter backers helped bring Perception to life. And priced just north of 20 bucks, Perception is definitely easier on wallets than AAA FPS VI: Unlimited Shootery.

Of course, "Best Of" awards aren't given out based on potential. To top it off, we have no shortage of horror games trying to elbow each other out of the way and become the next Amnesia. In other words, despite its pedigree, Perception faces a crowded field and weary gamers suffering from jump-scare fatigue.

So let's lead off the review proper with that clever, original hook. Perception takes the afraid-of-the-dark horror element and turns the dial up so furiously that it blows right past 11 and snaps clean off. See, its protagonist, Cassie, can't see, at least not in the traditional sense. In order to obtain a "visual" representation of her surroundings, players must use echolocation. By striking her cane against the ground or against objects, we "see" whatever the sound bounces off of, presenting us with an image of the room that we're in. Staying faithful to this mechanic, it is possible, at least in theory, to navigate Perception's haunted house with limited cane-thwapping, since Cassie's footsteps also trigger the effect, albeit with a far more limited radius.

After the briefest of prologues, our plucky heroine arrives at the door of Echo Bluff in Gloucester, Mass. Why is she there? Well, in a word, dreams. She decides that rather than being haunted by a phantasmal manor when she sleeps, she'll travel cross-country and experience the real thing. Certainly not among the best life decisions, but there are flimsier reasons to book your hero a one-night stay at the New England Haunted B&B.

Naturally, you're not the only boarder at this quaint, crazy estate. Echo Bluff has its share of ghosts, including the spectral Presence, Perception's monster. Using echolocation alerts the Presence to your, well, presence, in theory

adding an element of danger to your mission, but in practice it's the game's biggest misfire, squandering what could've been an intriguing and terrifying game of cat and mouse. Rather than having the Presence actively stalking you throughout Echo Bluff and giving Cassie a sonic arsenal to distract, confuse, or otherwise misdirect the Presence, you actually have to *try* to bring the monster barreling toward you, tapping your cane like you're part of a high school drumline. Aside from a handful of scripted encounters, through judicious use of your echolocation you can make your way through Echo Bluff almost completely unmolested.

As you work your way through four distinct yet connected mini storylines, Echo Bluff reconfigures itself to present you with a new house to explore each time. This definitely beats traipsing around the same house for four hours, but it's not quite the same brain-bending, stomach-turning trickery as Layers of Fear's haunted house, which in retrospect might deserve even more praise. Despite its dubious impetus and a shaky third act, Perception tells a pretty good story, at least.

Just like there are no "Best Of" awards for a game's potential, we're not really supposed to review games based on what they could have been. Yet for all its faults and rough edges, developer The Deep End Games took a big risk to give us a horror game we haven't seen before (if you'll pardon the terrible pun). Perception is far from perfect, but it's good enough that we'll be first in line for The Deep End's next effort. ■

Q&A With Jaron Schneider

How Digital Photography Hurt Professional Photographers

Jaron Schneider knows about photography. Beyond owning his own commercial cinematography and photography production company, Schneider is the managing editor of the web presence for the photo- and video-oriented *Resource Magazine* and is the tech editor of that publication's print edition. Schneider is also the former editor of the photography-focused Fstoppers.com and regularly writes about his profession. Such credentials leave Schneider well-positioned to comment on the state of photography in general and professional photography in particular, something he recently did in an article titled "In Making Photography Accessible To All, Photography Killed Itself," which he wrote for ImagingResource.com.

In the article, Schneider details several ways he believes digital photography has negatively impacted the field of professional photography, including devaluing it to the point that making a living has become more difficult as well-paying jobs have declined while at the same time more photographers calling themselves "professional" have entered the marketplace. Schneider essentially argues that while digital photography made photography more accessible compared to the days of film cameras and led to a period of innovation and advancements by camera and accessory makers, it also commoditized photography to the extent that "if everyone is a photographer, no one is." We spoke with Schneider about the impact digital photography has had on his trade, the role smartphone cameras have played in this, and more.
(*You can read our full conversation at* www.computerpoweruser.com/24525)

Q: Your recent article outlined several points concerning the negative impacts digital photography has had on professional photography. What are some notable impacts you've seen?

JS: One of the things I noticed early on, and this was pretty well known, is that the guys who were shooting in the 1970s and 1980s and were on top of their game back then and still shooting in film, they were the first to complain about digital and how it was costing them work. I think that was due to photography just becoming more accessible. Being a film photographer was not easy, and the best film photographers were developing their own shots. So when you get digital in there and suddenly it's much, much easier to have access to photos, you find people who didn't have the ability to shoot film were now able to shoot. And because a lot of those film guys didn't take digital seriously at first, they were finding themselves suddenly falling behind, until digital overtook film. So they would complain about it.

The first reaction to that from guys my age who grew up in the digital age who also had a background in film was a "Then get good, old man" sort of thing. "Stop trying to hold on to the past, and let's move forward" or "You're not as good as you used to be." It was a very smug outlook on it, but it didn't stop there. It kept going. We were at the point where not only were you able to get access to the ability to create better images, but you still needed an idea of how to use a camera. Now, you don't even need to know how to use a camera, and you can create good images. And it keeps steamrolling and getting worse. Now, you don't even need skill. We went from needing skill and access to just needing skill to now not needing anything.

As far as what I've seen in the industry, the amount of money people are willing to pay for something has gone from what I would consider almost ludicrous—we're talking $500,000 budgets for a few images not that long ago—to now we're lower for sure, $20,000 to $30,000 for high-end

specialty images, but that price keeps dipping. There's a certain point where you can't actually make any money because it still costs quite a bit to create an image, even though it's in digital. People aren't considering the cost of everything beyond snapping the photo. You have the gear cost. You have the lighting cost. You have grip cost. You have model cost. You have time, studio, all that stuff still costs money. So by the time you've billed, say, $27,000 for a commercial campaign, you're only walking away with $1,000 or $2,000. If you spent a whole month building this campaign to make $2,000, that's not sustainable.

Q: How did things shift so dramatically?

JS: There were two things in play. One of those was because of the access to equipment. The way we used to get professional photographers was there were a few of them and someone would apprentice with one, learn the ropes, and then become their own photographer. This sort of prevented too many from entering the market, but it also trained them all to understand the value of what they were doing. When you took away the need for apprenticing, you ended up with skilled photographers with no idea of what their photography is worth. So they'll charge almost nothing for the same thing as the guy who will charge $100,000 or $200,000 for the images.

I have friends who are in commercial photography—I actually chose not to enter commercial photography as my main job because I saw this happening and didn't want to compete in it. I'm a videographer mainly because video still has huge value. But in commercial photography, I know a guy who bid on a project for a water vehicle company. I think he bid $90,000, and the guy he lost to bid like $8,000. He had no idea what he left on the table. He could have quadrupled his budget and still won, but he didn't because he doesn't know. That's the problem. They're not trained, so they don't know.

The other problem is that everyone with a cell phone now thinks he's only a couple of steps away from getting the image he envisions that he'd hire the photographer to do. One of the jobs I worked on last year, there was a specific shot that the client had in mind that he wanted, and he sent us an iPhone video of what he wanted and said, "Just use this but make it look a little better." Because he was able to get 90% there with his phone, he assumed it would be easy to get 100% with the specs and gear he wanted us to use, which is ludicrous. It was not possible to do. He wanted a shot specifically of one of the wheels on one of the rail cars in San Francisco. You can get that on an iPhone because no one thinks anything of it if you just lean over and get your phone next to a wheel. But if you whip out a camera to get that in slow-motion 4K and suddenly you don't have a permit for that, there's other stuff at play there. The idea that someone could get so close to what they want with what they have in their pocket is really skewing his idea of the tech challenge of doing it for real.

Q: Your article suggested the "value of the photographer has fallen," including because everyone now believes they're a "weekend class" and "nice camera" away from being a professional photographer. Is this all due to smartphone cameras and the ease they provide? Has the smartphone caused people to lose the reverence they seemed to once have for professional photographers and the skill they traditionally possessed?

JS: I really do think that is a major player in it—the cell phone and before that, it was the Canon Rebel, for example. The Canon Rebel with a kit that a mom can take pictures of her kids playing soccer. That is molding and forming more into what we see now where we think we can get everything we want with the camera that's in our pockets. Because it's so cheap and accessible, it is like, "Why should a photographer be able to charge such and such to shoot a wedding when I clearly can get great photos on my iPhone? I don't understand why this person charges $8,000 for a wedding. I could just take the pictures." They don't fully think about the ramifications of creating the image. They only think about pushing the shutter button. There's so much at play, but many don't think about that. "This photographer doesn't have any value because I can take those pictures"— that's just what's in the back of their minds, and it really frames their vision of photographers. You asked if people have reverence for photographers anymore. They don't. You tell people you're a photographer now and their answer basically is, "Oh, that's cute."

Q: How has social media impacted photography in general and professional photographers specifically? Have Instagram, Snapchat, and other platforms changed people's perceptions about what represents a good photograph? Are photos now less about the skill, quality, and storytelling and more about the ability to quickly share them?

JS: For the everyday person, I would say, yes, it's more important to share immediately than take a good picture. But for someone who is trying to make money, it's kind of a weird mix. It's a mix of telling a story with maybe a crappy photo to 1 million followers. If you can tell a good story with a terrible picture, then it doesn't matter because a lot of people won't read captions. But if you can capture a picture that's good enough, then you're in. In regard to social, what I've seen over the past few years has been interesting to me because it's still evolving. For a while there, it was about how many followers you could get and then companies would dump money into you to spread their name to your followers, regardless of the quality of your work. It got to a certain point where they would hire these Instagram photographers who had never done a job like this in their lives and be like, "Here, we're going to give you a GMC. For two weeks, we want you to just post a picture a day of

it in different environments." Sometimes, that works. Sometimes, they realize this person has no idea what they're doing.

I'd say in the past year, the amount of money companies are willing to throw at "influencers" has decreased greatly because so many of these "influencers," which just means people with followers, just aren't good at running a business the way that

soured the whole market. We actually had a podcast about this a few weeks ago on Imaging Resource where we talked with someone who did get a lot of their original success through marketing through Instagram and found it to be a dying area. She called it the "fastfoodification of Instagram images" where everything is now looking the same and everything is just

I'm an artist, and I realized it when I was sitting in a typical office job feeling my soul get crushed just because it was not conducive to an artist's brain—an office building, repeated tasks, other people—a lot of these things I don't like. For me, it's not really a choice I had any real part in making. I have to do this. I'm a terrible painter. I have no drawing skill. I have these images in my mind I have to create. If I can't do that I'd wither and die. So to ask me if I'd make this decision again, I'm not even sure it was a conscious decision. It was one I had to do because if I didn't I'd be overweight and unhappy.

The main thing I think that's important to look at with this question is who are you as a person? Are you an artist or are you a businessman looking to use a camera? Because there is a difference. You do need to have a business sensibility to you, but you'll find the best photographers are bad at their own business. They hire other people to manage the business for them because the real good photographers are actually artists. So are you an artist? Or are you a person who enjoys the technology of the camera? If the answer is, "I'm not an artist. For some reason, I can't get the visualization these other guys have when they create images. I can't make that happen. I just really enjoy taking pictures, even if they're not going to be that good," then you probably shouldn't be a professional photographer. You could be a hobbyist.

There is absolutely nothing wrong with being a relatively skilled hobbyist. I was at Mono Lake about a month and half ago in California. I was out there at the crack of dawn. I thought I was going to be out there by myself. There was one other person there shooting basically the same scene as me. He was a retired Intel engineer, and he was like 45 and already retired because he enjoys seeing the world and taking pictures, but he knew that his skill was somewhere else. He worked so that he could retire and then enjoy taking pictures even if he was never going to sell a single one. It was just for the love of taking it. ∎

> I'm going after a totally different market working with businesses, basically the "traditional" way because that still works if the quality of your work is good enough.

a business needs them to run it. They're just not going to be able to get a return on their investment that they thought. Those 1 million followers who see the GMC, how many are actually going to go and buy a GMC? It turns out, very few. They're really in it just for the pictures that the photographer posted. So social was at a point where I thought it was kind of disgusting, where we were getting so many influencers getting millions of dollars tossed at them, but actually, it's starting to correct itself. I don't see this as being as big of a deal because there are too many of them and too many bad ones.

A lot of photographers who are actually good at this, who are good at leveraging their market and good at creating good images but they don't have 1 million followers, they have like 36,000 followers, but they're a very locked-in 36,000— they're actually more valuable. But because of the ones who had like 2 million but kind of average followers who didn't really invest heavily in that person, they sort of

getting pumped out quickly, and it's just not sustainable for them.

If you would have asked me this question a year ago, I would have had a different answer to how you should be using social. I have an Instagram, but I do not publish to it. I do not care about it. I do not do anything with Instagram, and I'm just fine because that's not the kind of thing I'm going after. I'm going after a totally different market working with businesses, basically the "traditional" way because that still works if the quality of your work is good enough.

Q: If you were starting your career today knowing what you do, would you still pursue photography as a profession?

JS: It's a tough question to answer because when I started out I wasn't a photographer. I went to business school. I have a marketing degree. I was in marketing right out of college, but

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lanfest.intel.com/events/mlp017summer

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Oklahoma City, OK
www.okgg.org

07.15-16.17
River Valley LAN
Russellville, AR
www.elayin.com

07.15.17
Source Gaming Lounge
Denton, TX
www.sourcegaming.org

07.21-23.17
DREAMHACK Atlanta 2017
Atlanta, GA
atlanta.dreamhack.com/17

07.21-24.17
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Portland, OR
www.pdxlan.net

07.28-30.17
BAKOLAN
Bakersfield, CA
www.facebook.com/groups/Bakolan

07.28-30.17
SAN LAN: Summer Splash
San Antonio, TX
www.SanLAN.org

07.29.17
eDrenaline eSports
Ashland, OH
www.facebook.com/groups/UGGeSports

07.29.17
KCGameOn 76
Kansas City, MO
kcgameon.com

08.04-05.17
CogLAN v3.0
Powell, OH
coglan.org

08.19-20.17
eDrenaline eSports
Ashland, OH
www.edrenaline.net

08.19.17
Oklahoma Gamers Group
Oklahoma City, OK
www.okgg.org

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west.paxsite.com

09.15.17
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www.okgg.org

09.15.17
Source Gaming Lounge
Denton, TX
www.sourcegaming.org

09.16-17.17
LanOC v2.0
Van Wert, OH
lanoc.org/lan-parties

09.22-24.17
PONG EXPO LAN
Menomonie, WI
pong.uwstout.edu

09.30.17
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Ashland, OH
www.facebook.com/groups/UGGeSports

10.07.17
KCGameOn 77
Kansas City, MO
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10.07-08.17
River Valley LAN
Russellville, AR
www.elayin.com

10.20-22.17
DREAMHACK Denver 2017
Denver, CO
denver.dreamhack.com/17

10.21-22.17
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www.lacledeslan.com

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Q&A With Miguel Couvertier

U.S. Managing Director On EKWB's New Fluid Gaming Cooling Kits

Q: EKWB recently launched its new Fluid Gaming line of cooling kits; what kits are in the new line, and what does each one come with?

MC: We have three kits under the Fluid Gaming brand. The first is the A120, which is a processor-only cooling loop, containing everything you need: the block, fittings, pump, radiator, and all tools required. The next kit is the A240, which is the exact same as the A120 but with a larger (240mm) radiator, an additional Vardar fan, and a PWM cable splitter. Our third and most popular kit, the A240G, is the game changer. It includes everything in the A240 kit but also offers two additional fittings, a backplate, and waterblock that is compatible with Reference 10 series and Titan X/Xp video cards. This is the first kit to offer both CPU and GPU liquid cooling and comes in at only $239.99.

Q: EKWB has had cooling kits for quite a while now; how are your Fluid Gaming kits different, and what were the company's goals in designing these new kits?

MC: Yes, we have had kit offerings for a few years now, but what makes these kits special are their price-to-performance ratio. Using aluminum as the base material, we were able to cut costs down significantly, while still keeping premium performance. We have heard customers for many years now saying they want to watercool but just felt it was too expensive. Our goal and belief with this lineup is that everyone should be able to experience watercooling their PC at a price they can afford.

We use automotive-grade copper in our standard line of products, which gives top-of-the-line performance but a higher price tag.

Our R&D team has spent over a year testing and designing these blocks to make sure performance and efficiency are still held to our own standards but at a cheaper price. The aluminum blocks still perform extremely well with test results showing around 55 degrees Celsius at max load on graphics cards. The Fluid Gaming kits don't perform as well as the copper series, but the performance difference is minimal and the price tag is in line with high-end AIO coolers.

Q: Will your A240G kits include blocks for graphics cards other than NVIDIA GeForce GTX 10-series cards at some point? Just wondering if there will be, for example, blocks for Radeon RX 5-series cards and/or Vega-based cards?

MC: We will definitely be updating this kit as new series of cards are released and have plans to fully support AMD's Vega lineup when it is released. At this time, we plan to only offer support for reference-design models to make it universal and easy to install for everyone.

Q: The coolant concentrate in the Fluid Gaming kits is clear, right? If users want to, can they add some color to the coolant, or do they need to get different concentrate? If they can do that themselves, what's the best way to go about it?

MC: Yes, we include a clear concentrate in all our Fluid Gaming kits that needs to be mixed with distilled water. We also offer the option to customize the color to match your build theme using our full line of CryoFuel coolant premixes and concentrates, which are fully compatible with the Fluid Gaming kits. They are available through all our resellers and at www.ekwb.com/shop.

Q: Do you have any plans to offer a Fluid Gaming kit with a 360mm radiator?

MC: Originally, we made only 120 and 240mm options in the kits to ensure broad case compatibility—the majority of mid-tower cases usually support a 240mm at max. We have heard the requests from many people, though, and will offer a compatible 360mm aluminum radiator very soon for purchase separately.

Q: If someone gets an A240G and then upgrades to an SLI setup, can they get a second, matching GPU block?

MC: We are currently not offering individual components, as the major focus has been on production of the kits for the launch. We will be offering additional blocks for purchase very soon and even have plans for a Vega waterblock, angled fittings, additional fitting colors, and other accessories. We understand that overclocking and SLI setups are a big reason why people watercool and will fully support it. ■

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